PACIFIC SLOPE CRETACEOUS BIVALVES OF THE GENUS *CALVA*

L. R. SAUL[1] AND W. P. POPENOE[2]

CONTENTS

ABSTRACT 1
INTRODUCTION 2
SOURCES OF MATERIAL STUDIED 3
DISTRIBUTION 3
FEATURES MEASURED 9
CHANGES IN *CALVA* THROUGH TIME 9
SUMMARY 10
ABBREVIATIONS 10
SYSTEMATIC PALEONTOLOGY 10
  Genus *Calva* Popenoe, 1937 10
    Subgenus *Calva* Popenoe, 1937 12
      Calva (*Calva*) *heliaca,* new species 12
      Calva (*Calva*) *regina* Popenoe, 1937 13
      Calva (*Calva*) *campanae,* new species 15
      Calva (*Calva*) *peninsularis* (Anderson and Hanna, 1935) 17
      Calva (*Calva*) *varians* (Gabb, 1864) 19
      Calva (*Calva*) *baptisia,* new species 24
    Subgenus *Egelicalva,* new subgenus 26
      Calva (*Egelicalva*) *byblidis,* new species 27
      Calva (*Egelicalva*) *nitida* (Gabb, 1864) 27
      Calva (*Egelicalva*) *spissa,* new species 32
      Calva (*Egelicalva*) *taffi* (Anderson, 1958) 34
      Calva (*Egelicalva*) *buttensis* (Anderson, 1958) 36
      Calva (*Egelicalva*) *bowersiana* (Cooper, 1894) 39
      Calva (*Egelicalva*) *crassa,* new species 44
    Subgenus *Microcalva,* new subgenus 48
      Calva (*Microcalva*) *elderi,* new species 48
      Calva (*Microcalva*) *haggarti,* new species 50
    Subgenus *Penecallista,* new subgenus 53
      Calva (*Penecallista*) *marina,* new species 53
ACKNOWLEDGMENTS 57
LITERATURE CITED 57
LOCALITIES CITED 60

ABSTRACT. *Calva* is the common, venerid bivalve genus of shallow water North American Pacific Slope Cretaceous deposits. Sixteen species placed in four subgenera range in age from Albian through latest Maastrichtian. Six species (*Calva heliaca,* new species, Cenomanian; *C. regina* Popenoe, 1937, Turonian; *C. campanae,* new species, late early to late Campanian; *C. peninsularis* (Anderson and Hanna, 1935), latest Campanian–early Maastrichtian; *C. varians* (Gabb, 1864), mid and late Maastrichtian; and *C. baptisia,* new species, latest Maastrichtian) constitute the typical subgenus and give it an age range of Cenomanian through Maastrichtian. Seven species (*Calva byblidis,* new species, early Albian; *C. nitida* (Gabb, 1864), late Albian-Cenomanian; *C. spissa,* new species, Turonian; *C. taffi* (Anderson, 1958), Coniacian-Santonian–earliest Campanian; *C. buttensis* (Anderson, 1958), early Campanian; *C. bowersiana*

---

[1] Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007.

[2] Department of Earth and Space Sciences, University of California–Los Angeles, Los Angeles, California 90024. (Deceased 1981.)

Contributions in Science, Number 433, pp. 1–68
Natural History Museum of Los Angeles County, 1992

(Cooper, 1894), late early–late Campanian; and *C. crassa,* new species, early Maastrichtian) constitute the new subgenus *Egelicalva,* giving it an age range of Albian through early Maastrichtian. *Calva elderi,* new species, Coniacian, and *C. haggarti,* new species, Campanian, constitute the new subgenus *Microcalva,* and *Calva marina,* new species, late Campanian–early Maastrichtian, is type species of the new subgenus *Penecallista.*

Although there is no obvious directional change in the external morphologic features studied, there is evidence of a trend in hinge morphology in the evolutionary lineages of *Calva* that is apparently traceable through the Late Cretaceous.

The restricted age ranges of species in these lineages makes them useful in dating deposits of Late Cretaceous age. In addition, the typical subgenus has a more southern distribution than the subgenus *Egelicalva,* suggesting that changes in their distributions through the Late Cretaceous may aid in climatic reconstructions.

INTRODUCTION

Venerid bivalves, especially of the genus *Calva,* are a common constituent of shallow water Late Cretaceous marine faunas of the Pacific Slope from Alaska south to Baja California. Two species of *Calva, Meretrix nitida* Gabb, 1864, and *Venus varians* Gabb, 1864, were among the earliest described bivalves of Cretaceous age from California. However, these and other species of *Calva* have been imprecisely diagnosed and their geologic occurrences incorrectly recognized, in part because several species are quite similar and easily confused. With careful discrimination the species can be useful in dating beds of Late Cretaceous age. Most species of *Calva* from northeast Pacific Slope deposits appear allocatable to two lineages or subgenera. Geographic occurrences of these two subgenera, *Calva* and *Egelicalva,* suggest that the typical lineage was more thermophilic than the other.

Popenoe (1937) proposed the genus *Calva* to include several Pacific Slope Cretaceous venerid species of medium to large size. He designated as type species *Calva regina* Popenoe, 1937, of Turonian age, and referred *Meretrix nitida* var. *major* Packard, 1922 = *Cucullaea bowersiana* Cooper, 1894, to *Calva.* He also tentatively included two much-cited species described by Gabb in 1864, *Venus varians* and *Meretrix nitida,* although at that time (1937) neither the morphology nor stratigraphic occurrence of either species was clearly understood. Gabb (1864) cited the two species as occurring together at four California localities: Cow Creek, Shasta County; Orestimba Canyon, Stanislaus County; Chico Creek, Butte County; and Division A at Martinez, Contra Costa County, and the two species have continued to be jointly cited from numerous Cretaceous localities by many workers up to the present. Gabb did not designate type specimens or type localities and gave no explanation for placing *V. varians* and *M. nitida* in different genera. He provided no description of the hinge of either species.

Whiteaves (1879) originally identified specimens that should probably be referred to *Calva* from several localities in the Nanaimo Basin deposits, British Columbia, as *Cytherea* (*Caryatis*) *plana* Sowerby, 1812, a species of late Albian age described from the Upper Greensand of Blackdown, Devon, England, but in 1903 he referred them to *Meretrix nitida* Gabb, 1864, a species of latest Albian and Cenomanian age. Whiteaves' material is presently only partially available, but his *Cytherea* (*C.*) *plana* and *M. nitida* are *Calva.* Some of his figured specimens have been misplaced, and the horizon and locality for a number of his specimens are imprecise.

The first step toward discriminating between Gabb's species and assigning them to an appropriate genus was made by Stewart (1930) who figured one of Gabb's original specimens of *Venus varians* and designated ANSP 4383 as lectotype. He figured two of Gabb's specimens of *Meretrix nitida* but designated neither as lectotype. He considered that *V. varians* and *M. nitida* might be conspecific but noticed subtle shape differences between specimens of the two separate lots. He partially exposed hinges of both species, showing that anterior lateral teeth are present in both, and, therefore, referred both species to *Aphrodina* Conrad, 1869. He considered the type locality of both to be Martinez, Contra Costa County, California, but commented that the striking differences in preservation might indicate that more than one stratum and perhaps more than one locality was included under the name "Martinez." He dated the Cretaceous fauna from "Martinez" as Cenomanian or earlier, an age appropriate to *M. nitida,* but not for *V. varians,* which is now known to be of Maastrichtian age.

Popenoe (1937, p. 395) indicated that *Venus varians, Meretrix nitida, M. nitida* var. *major* Packard, and *C. regina* Popenoe differ from *Aphrodina* in having posterior lateral teeth. At this time, he also tentatively assigned *Meretrix umzambiensis* Woods, 1906, from the Late Cretaceous of Pondoland, South Africa, to *Calva,* being unaware that *M. umzambiensis* had been designated type species of *Trigonocallista* Rennie, 1930 (p. 177). Upon discovering Rennie's designation, Popenoe sent specimens of *Calva* to Rennie at Rhodes University College, Grahamstown, South Africa. Rennie opined that *T. umzambiensis* was congeneric with the California specimens, and Popenoe (1940) placed *Calva* in the synonymy of *Trigonocallista.* Casey (1952, p. 172), however, recognized both genera because *Calva* was described as having smooth sided anterior lateral teeth, whereas *Trigonocallista* has striated anterior lateral teeth. He considered them both to be dosiniopsids.

Anderson (1958, p. 138) provided two new names for species of *Calva* collected at Chico Creek and figured by Taff et al. (1940): *Trigonocallista taffi* Anderson for *T. nitida* (Gabb) (Taff et al., 1940, pl. 2, figs. 3–4) and *T. buttensis* Anderson for *T. varians* (Gabb) (Taff et al., 1940, pl. 2, figs. 10–11).

Seven of the 15 species referable to *Calva* s.l. that are present in northeast Pacific Slope Cretaceous beds were named prior to this study. To these are added nine new species, giving the genus a time range in this region of Albian through Maastrichtian. In the past generic and specific relations have been obscured by incomplete knowledge of morphology of some species, careless identification of many specimens, and resultant confusion of the stratigraphic occurrences of species. This paper summarizes the species comprising *Calva* and their morphologic, geographic, and stratigraphic distinctness. This work was begun by W. P. Popenoe who gave a paper on *Calva* at the 1963 Cordillerian Section of the Geological Society of America (Popenoe, 1964, p. 219) and has been completed by L. R. Saul.

SOURCES OF MATERIAL STUDIED

During the years that he studied the Late Cretaceous molluscan faunas from the Pacific Slope of North America, Popenoe amassed collections that were carefully located geographically and stratigraphically, many of which contained specimens of the venerid bivalve *Calva*. Figure 1 indicates areas from which such specimens have been collected, and localities are keyed to it by a bracketed number. A framework for the study of this group is provided by several important sections. The Cretaceous sections at the northern end of the Sacramento Valley in the vicinity of Ono [9] and east of Redding [8], Shasta Co., comprising the Budden Canyon and the Redding Formations, have provided venerids of Albian through Santonian age. Outcrops of the Chico Formation, especially along Chico Creek [11], have provided venerids of Santonian through early Campanian age. The Santa Ana Mountains [26] section in Orange Co., comprising the Ladd and Williams Formations, has yielded venerids of Turonian and late Campanian age. In the Simi Hills [24] of Los Angeles and Ventura Cos., the Chatsworth Formation has yielded venerids of mid-Campanian through early Maastrichtian age. Although megafossils are sparse in much of the thick Great Valley Series cropping out along the western border of the San Joaquin–Sacramento Valleys, the region has provided venerids of Albian through late Maastrichtian age. North and south of Lake Nacimiento [21] in San Luis Obispo Co., outcrops of the El Piojo Formation have yielded late to latest Maastrichtian venerids.

Other areas from which important collections have been made include the Nanaimo Basin [1–3] in southern British Columbia and San Juan Co., Washington; the Hudspeth Formation in Wheeler and Grant Cos. [4], Oregon; the Hornbrook Formation in Jackson Co. [6], Oregon and Siskiyou Co. [7], California; the Jalama Formation in western Santa Barbara Co. [22], California; the Point Loma Formation of the Rosario Group in San Diego Co. [28], California; and the Rosario Formation in northern Baja California, Mexico [29].

Type specimens of the named taxa were borrowed. If preservation of the specimen was adequate and permission was granted by the loaning institution, matrix was removed so that the hinge teeth could be seen. New collections from type localities of described species have made possible assessments of the range of variation in these species. Although the type localities of species described by Gabb and Cooper lack precision, comparison of type material with large collections from the vicinity of the "type locality" has made it possible to assign these species to descrete horizons. Taxa included in *Calva,* especially *Venus varians* and *Meretrix nitida,* have been reported from many localities; reassessment of reported identifications has been effected by examining the specimens upon which the reports were based and/or by studying larger, better located collections from the area.

Calvas most commonly occur in sandstone deposits. Where specimens are not obviously displaced downslope, the conditions appear to have been normal marine and sublittoral, near or below wave base. *Calva* is commonly part of a fairly diverse molluscan assemblage that lived off-shore from communities dominated by *Cymbophora* and in slightly coarser substrate than those in which *Crassatella* was most abundant. Although common in many collections, *Calva* does not usually constitute more than a third of recovered specimens. In comparison to some thinner shelled bivalves in the same deposits, specimens of *Calva,* which are relatively robust, probably have a better recovery rate from hard matrix and are therefore disproportionally abundant in museum collections. Although all *Calva* have a well-developed pallial sinus and were doubtless infaunal filter-feeders, shell morphology and the typically disarticulated preservation of shells indicate that *Calva* was probably a shallow burrower.

DISTRIBUTION

In addition to the four Pacific Slope species, *Venus varians, Meretrix nitida, Cucullaea bowersiana,* and *Calva regina,* Popenoe (1937, p. 395) suggested that *Meretrix umzambiensis* from South Africa, *Cytherea subrotunda* Sowerby and *Cytherea caperata* Sowerby from England, *Dosiniopsis nebrascensis* (Meek and Hayden, 1856) from the Western Interior, and *Callista pseudoplana* Yabe and Nagao, 1925, from Hokkaido, Japan, might be referred to *Calva.* The generic placement of *M.*

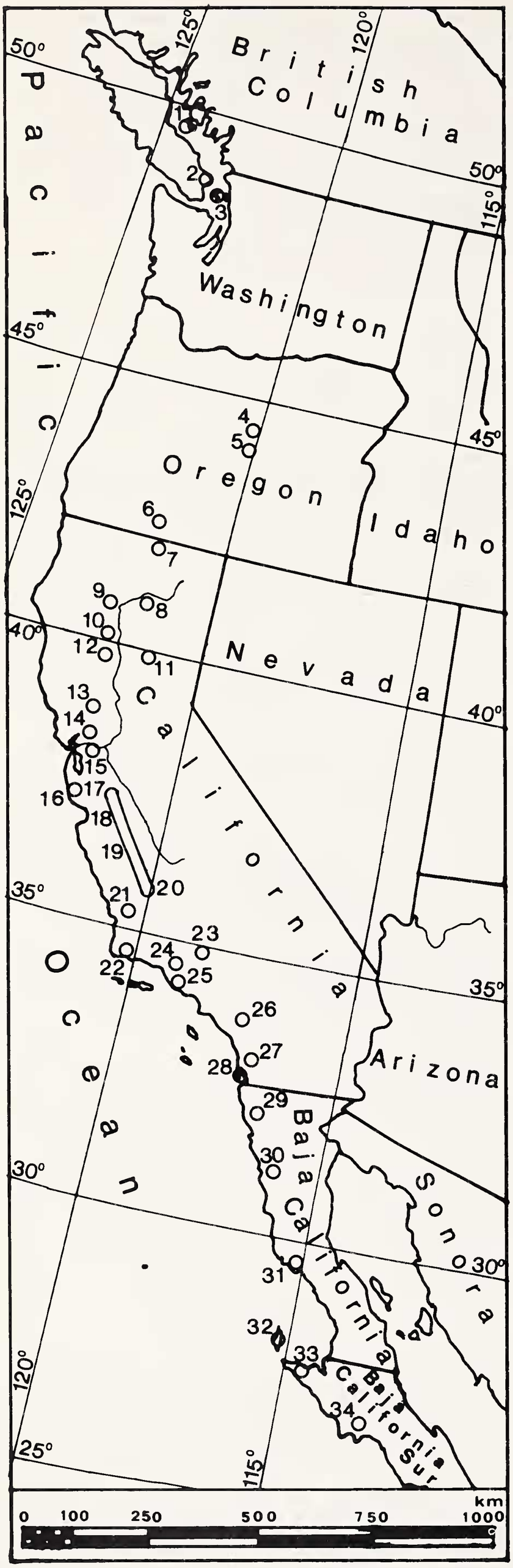


Figure 1. Index map to geographic occurrences of *Calva* spp. Localities are grouped into 33 areas that are numbered from north to south: 1—Denman Island, Hornby Island, and Texada Island, British Columbia. 2—Departure Bay and Nanaimo, Vancouver Island, British Columbia. 3—Sucia Island, San Juan Co., Washington. 4—Dayville, Grant Co., and Rock Creek, Wheeler Co., Oregon. 5—Andy Bernard Ranch and Suplee, Crook Co., Oregon. 6—Ashland Creek and Jacksonville, Jackson Co., Oregon. 7—Rancheria Gulch and Young Ranch, Siskiyou Co., California. 8—Clover Creek, Cow Creek, Dry Creek, Oak Run, Price Hollow, Redding, and Stinking Creek, Shasta Co., California. 9—North Fork of Cottonwood Creek, Ono, and Texas Springs, Shasta Co., California. 10—Elder Creek, Tehama Co., California. 11—Butte Creek, Chico Creek, and Pentz, Butte Co., California. 12—Stony Creek, Glenn Co., California. 13—Antelope Creek, Peterson Ranch, and Sites, Colusa Co., and Thompson Creek, Yolo Co., California. 14—Benicia and Glenn Cove, Solano Co., California. 15—Curry Canyon, Deer Valley, and Martinez, Contra Costa Co., and Pleasanton area, Alameda Co., California. 16—Bolsa Point, San Mateo Co., California. 17—Garzas Creek, Orestimba Creek, and Salado Creek, Stanislaus Co., California. 18—Laguna Seca, Los Baños Creek, Pacheco Pass, and Ortigalita Creek, Merced Co., California. 19—Coalinga, Cooper Canyon, Los Gatos Creek, Fresno Co., California. 20—Garza Peak, McClure Ridge, north of Sunflower Valley, Kings Co., California. 21—Cantinas Creek, Dip Creek, Lake Nacimiento, San Luis Obispo Co., California. 22—Jalama Creek, Sisquoc River, Hurricane Deck Quadrangle, Santa Barbara Co., California. 23—Warm Springs Mountain, Los Angeles Co., California. 24—Bell Canyon, Simi Hills, Ventura Co., and Dayton Canyon, Los Angeles Co., California. 25—Santa Monica Mts., Los Angeles Co., California. 26—Baker and Black Star Canyons, Bee Canyon, Holz Ranch, Pankratz Ranch, Wildcat and White Canyons, and Williams Canyon, Santa Ana Mts., Orange Co., California. 27—Carlsbad area, San Diego Co., California. 28—La Jolla and Point Loma, San Diego Co., California. 29—Punta Banda, Baja California, Mexico. 30—San Antonio del Mar, Baja California, Mexico. 31—Vicinity of El Rosario and Arroyo Santa Catarina, Baja California, Mexico. 32—Cedros Island, Baja California, Mexico. 33—Northwest Vizcaíno Peninsula, Baja California Sur, Mexico. 34—Vizcaíno Peninsula inland from Punta Abreojos, Baja California Sur, Mexico. Place names mentioned in text listed alphabetically and assigned to a numbered area: 5—Andy Bernard Ranch; 13—Antelope Creek; 15—Arroyo del Valle; 31—Arroyo Santa Catarina; 6—Ashland Creek; 26—Baker Canyon; 26—Bee Canyon; 24—Bell Canyon; 14—Benicia; 26—Black Star Canyon; 16—Bolsa Point; 11—Butte Creek; 21—Cantinas Creek; 27—Carlsbad; 32—Cedros Island; 11—Chico Creek; 8—Clover Creek; 19—Coalinga; 19—Cooper Canyon; 8—Cow Creek; 15—Curry Canyon; 24—Dayton Canyon; 4—Dayville; 15—Deer Valley; 1—Denman Island; 2—Departure Bay; 17, 18, 19, 20—Diablo Range; 21—Dip Creek; 8—Dry Creek; 10—Elder Creek; 31—El Rosario; 20—Garza Peak; 17—Garzas Creek; 14—Glenn Cove; 26—Holz Ranch; 1—Hornby Island; 22—Jalama Creek; 6—Jacksonville; 18—Laguna Seca; 28—La Jolla; 21—Lake Nacimiento; 18—Los Baños Creek; 19—Los Gatos Creek; 15—Martinez; 20—McClure Ridge; 2—Nanaimo; 15—Niles Canyon; 9—North Fork of Cottonwood Creek; 8—Oak Run; 9—Ono; 17—Orestimba Creek; 18—Ortigalita Creek; 18—Pacheco Pass; 26—Pankratz Ranch; 21—Pebblestone Shut-In; 11—Pentz; 13—Peterson Ranch; 15—Pleasanton area; 28—Point

umzambiensis has already been mentioned. Casey (1952) considered *Cytherea subrotunda* to be a typical *Calva* and designated *Cytherea caperata* as the type species of *Chimela,* a new subgenus of *Calva.* Speden (1970) consigned *Dosiniopsis nebrascensis* to the synonomy of *D. deweyi* (Meek and Hayden, 1856) and considered the species appropriately placed in *Dosiniopsis,* thereby extending the range of *Dosiniopsis* back into the Late Cretaceous. Nagao and Otatume (1963) placed *Callista pseudoplana* Yabe and Nagao, 1925, in *Aphrodina.* Hayami (1975, p. 145) questionably refered *Dosiniopsis* (?) cf. *D.* (?) *caperata* (Sowerby) of Yabe and Nagao, 1925, from the Cape Khoi beds (Cenomanian–Turonian) in the Aleksandrovsk area, Sakhalin Island, Russia, to *Calva* sp. In contrast, *Trigonocallista ornata* Ichikawa and Maeda, 1963, from the Izumi Group (Campanian) in the Hiketa area, Tokushima Prefecture, Japan, has the striated nymph of a *Trigonocallista.* Only species from the Pacific Slope can with certainty be assigned to *Calva.*

The genus *Calva* persisted along the Pacific Slope of North America from Albian through Maastrichtian but does not appear to have been common elsewhere. Figure 2 plots chronologic ranges of the studied species. *Calva* has been recognized from Alaska south to the Vizcaíno Peninsula [34], Baja California Sur, Mexico. Only a few Alaskan specimens, mainly from the Campanian Chignik Formation west of Chignik Bay, have been studied. Reports (Whiteaves, 1879, 1895, 1896, 1903) indicated that *Calva* is common in Late Cretaceous deposits of southern Vancouver Island [1–2], British Columbia, but few specimens are available, and Nanaimo Basin *Calva* are represented in this study mainly by Campanian, *Hoplitoplacenticeras vancouverense* Zone, specimens from Sucia Island [3], Washington. Most of the specimens from Baja California, Mexico, are from the Rosario Formation and are of early Maastrichtian age, but a few specimens from formations as old as Cenomanian are available. California has provided the bulk of specimens and species over the most extensive time range and the best geographic distribution. However, Albian and Cenomanian deposits are unknown in Southern California, and the most studied deposits of Coniacian, Santonian, and early Campanian age of Southern California were laid down in moderately deep or deeper water and have as yet yielded no specimens of *Calva.*

The phylogenetic relationship between *Calva* s.s. and *Calva* (*Egelicalva*) is not known. *Egelicalva* appears in our records before *Calva* (*Calva*), and the shape of the earliest typical *Calva, C.* (*C.*) *heliaca,* which is probably of Cenomanian age, resembles that of *C.* (*E.*) *taffi* of Santonian age rather than *C.* (*E.*) *nitida* of latest Albian–Cenomanian age or *C.* (*E.*) *byblidis* of early Albian age. No *Calva* s.s. species can be unequivocally derived from a species of *Egelicalva,* but *Calva* and *Egelicalva* are so similar in hinge structures and shape that they are probably related.

Whiteaves (1879, p. 150; 1903, p. 377) listed specimens that would now be assigned to *Calva* as *Cytherea* (*Caryatis*) *plana* Sowerby or *Meretrix nitida* Gabb from several Nanaimo Basin [1–3] localities. Unfortunately, not all of his specimens are available. His localities included Departure Bay, near Nanaimo, northwest side of Hornby Island, "2¼ miles up the Nanaimo River," Texada Island, and Sucia Island. Work of Muller and Jeletzky (1970), Ward (1978), and Haggart (1989) suggests that Whiteaves' localities on Sucia Island, Texada Island, "2¼ miles up the Nanaimo River," and possibly near Nanaimo are from the Cedar District Formation; localities at Departure Bay and near Nanaimo may have been from the Pender or Haslam Formations, and the Northumberland and Spray Formations are mapped on the northwest side of Hornby Island. The Cedar District Formation is considered to be of early late Campanian age *Hoplitoplacenticeras vancouverense* and *Metaplacenticeras pacificum* zones; *Calva* from this formation on Sucia Island are *Calva* (*Egelicalva*) *bowersiana* and *Calva* (*Microcalva*) *haggarti.* We have not seen specimens from Departure Bay or near Nanaimo; the age range of the Haslam and Pender Formations is late Santonian to early Campanian (Ward, 1978; Haggart, 1989). In California, beds of late Santonian age have yielded *C.* (*E.*) *taffi,* and beds of early Campanian age have yielded *C.* (*E.*) *buttensis.* Four small specimens from Hornby Island identified by Whiteaves as *Meretrix nitida* Gabb are similar to *Calva* (*Microcalva*) *haggarti,* new species (see the discussion under this species); Northumberland and lower Spray Formations are of late Campanian age, and the upper Spray is early Maastrichtian in age (Haggart, 1989).

Figure 3 depicts the known latitudinal range of each species. Chronologic and geographic ranges are based largely on specimens in the collections of the Natural History Museum of Los Angeles County, the University of California, Berkeley, Museum of Paleontology, and the California Academy of Sciences, with additional data from collections of the U.S. Geological Survey, Menlo Park, Royal Provincial Museum, Victoria, British Columbia, and Geological Survey of Canada, Ottawa, Ontario.

←

Loma; 8—Price Hollow; 34—Punta Abreojos; 31—Punta Baja; 29—Punta Banda; 17—Quinto Creek; 7—Rancheria Gulch; 8—Redding; 4—Rock Creek; 17—Salado Creek; 30—San Antonio del Mar; 18—San Luis Reservoir; 22—San Rafael primitive area; 26—Santa Ana Mts.; 25—Santa Monica Mts.; 26—Santiago-Aliso Creek divide; 26—Silverado Canyon; 24—Simi Hills; 7—Siskiyou Mts.; 22—Sisquoc River; 13—Sites; 8—Stinking Creek; 12—Stony Creek; 3—Sucia Island; 20—Sunflower Valley; 5—Suplee; 1—Texada Island; 9—Texas Springs; 13—Thompson Creek; 2—Vancouver Island; 33, 34—Vizcaíno Peninsula; 23—Warm Springs Mountain; 26—White Canyon; 26—Wildcat Canyon; 26—Williams Canyon; 7—Young Ranch.

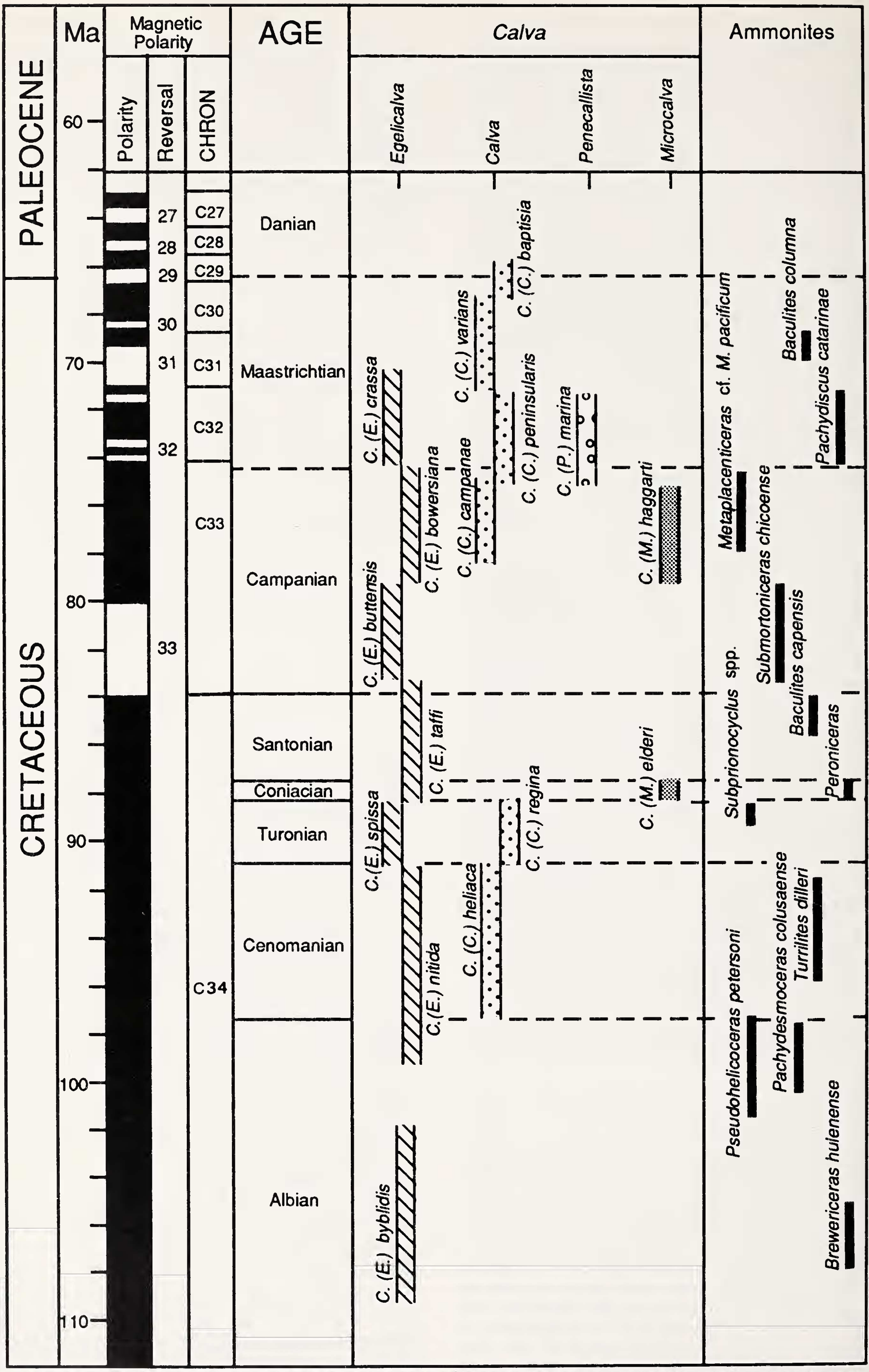


Figure 2. Geologic ranges of species of *Calva* from the Pacific Slope of North America plotted against geochronologic time scale, magnetic polarity (after Palmer, 1983), and selected ammonite ranges.

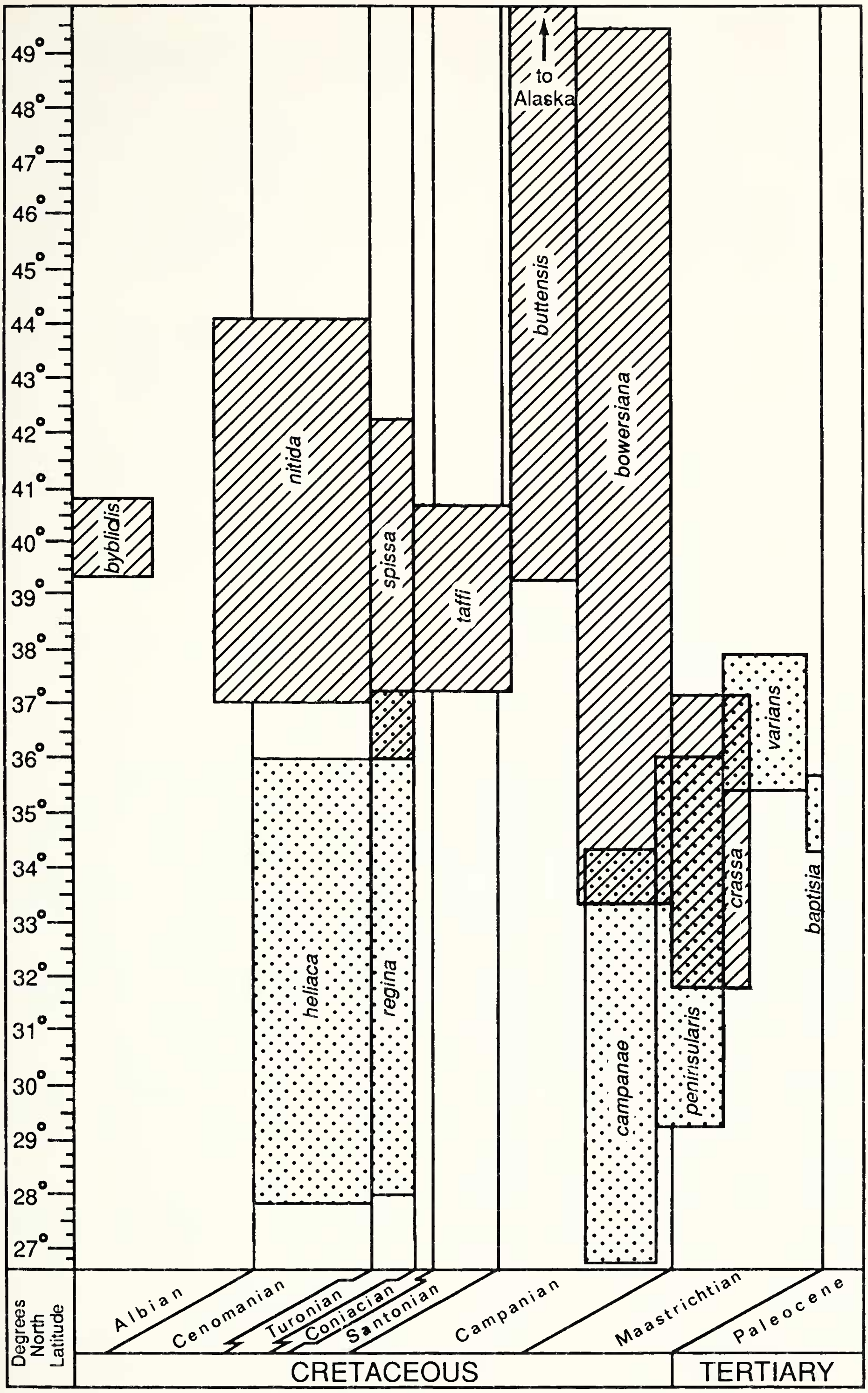


Figure 3. Latitudinal distribution of species of *Calva* and *Egelicalva,* based on range end points of Table 1. All occurrences of C. (C.) *regina,* C. (C.) *campanae,* and C. (C.) *baptisia* are west of the San Andreas fault. All occurrences of C. (*E.*) *byblidis,* C. (*E.*) *spissa,* C. (*E.*) *taffi,* and C. (*E.*) *buttensis* are east of the San Andreas fault. The northernmost occurrence of C. (C.) *heliaca,* C. (C.) *peninsularis,* C. (*E.*) *nitida,* C. (*E.*) *bowersiana,* and C. (*E.*) *crassa* is east and the southernmost occurrence west of the fault. Northern range ends are rounded-off north and plotted on the next northern quarter degree; southern range ends are rounded-off south and plotted on the next southern quarter degree. Species known only from essentially a single locality are given a latitudinal range of one degree.

Table 1. Range end points for *Calva* species.

	Northern end point	Southern end point
Calva (*Calva*)		
heliaca	36°N, McClure Ridge [20]	27°45′N, NW Vizcaíno Peninsula [33]*
regina	37°15′N, Quinto Creek [17]	28°N, Cedros Is. [31]*
campanae	34°15′N, Simi Hills [24]*	26°45′N, Vizcaíno Peninsula [34]*
peninsularis	36°N, Coalinga [19]	29°30′N, Santa Catarina [31]*
varians	38°N, Martinez [15]	35°45′N, Lake Nacimiento [21]*
baptisia	35°45′N, Lake Nacimiento [21]*	34°30′N, Warm Springs Mtn. [23]*
Calva (*Egelicalva*)		
byblidis	40°30′N, Texas Springs [9]	39°30′N, Sites, Colusa Co. [13]
nitida	44°N, Suplee, Oregon [5]	38°N, Martinez [15]
spissa	42°15′N, Jackson Co., Oregon [6]	36°N, Garza Peak [20]
taffi	40°30′N, Redding [8]	37°15′N, Orestimba [17]
buttensis	56°30′N, Chignik Bay, Alaska	39°50′N, Pentz [11]
bowersiana	49°30′N, Vancouver Is. [2]	33°30′N, Santa Ana Mts. [26]*
crassa	37°N, Ortigalita Creek [18]	31°45′N, Punta Banda [29]*
Calva (*Microcalva*)		
elderi	37°N, San Luis Reservoir [18]	
haggarti	49°30′N, Vancouver Is. [2]	48°45′N, Suicia Is. [3]
Calva (*Penecallista*)		
marina	35°45′N, Pebblestone Shut-In [21]*	31°N, San Antonio del Mar [30]*

* West of the San Andreas Fault.

These compiled latitudinal ranges (Table 1) are filtered through the usual deficiencies of the geologic record—incomplete sections, wrong ecotope preserved, and imperfect preservation of specimens, as well as tectonic transport. However warped by this filter, the occurrences of *Calva* (*Calva*) and *Calva* (*Egelicalva*) form a north–south pattern with species of *Calva* (*Calva*) displaying a more southerly distribution vis à vis contemporaneous species of the subgenus *Egelicalva*. Available Alaskan and Canadian collections surveyed suggest that many northern occurrences are unreported. Both the northerly distribution of several species of *Egelicalva* and the southerly distribution of species of *Calva* s.s. are likely to be extended by additional collecting. In general, specimens of *Calva* (*Egelicalva*) sp. show more accentuated growth checks than do specimens of *Calva* (*Calva*) sp. As strength of growth checks may be encouraged by a more seasonal climate with greater summer–winter food supply differential affecting growth potential, specimens from higher latitudes might be expected to exhibit stronger growth checks.

Actual latitudinal ranges have not only been obscured by deficiencies of the geologic record but have been additionally confounded by the unknown amount of terrane displacement between various *Calva*-bearing outcrops of similar age. Paleomagnetic data suggest a northward translation of many of the Cretaceous deposits (Fry et al., 1985), but the Figure 3 ranges are plotted at the present geographic positions of the rocks from which the specimens were collected. The best documented displacements are those of the San Andreas Fault system, which are relatively northward on the west. Some species have their entire geographic occurrence either east or west of this system, but others straddle it. *Calva* (*C.*) *peninsularis, C.* (*Egelicalva*) *bowersiana,* and *C.* (*E.*) *crassa* all have their southernmost occurrence to the west of this system, on the north moving block, and their northernmost occurrence east of the system. Their present apparent latitudinal range is less than their original distribution by the total displacement on the San Andreas system (approx. 500–600 km). Despite distributional offset due to terrane displacement, latitudinal ranges of time equivalent species of the *Calva* s.s. group are to the south of the ranges of the *Calva* (*Egelicalva*) group. Any terrane displacements across the San Andreas system appear to have been less than the original latitudinal ranges of these species.

Latitudinal ranges in the Cretaceous may have been broad, but the pattern of the *Calva* ranges argues for latitudinal restrictions not too unlike those of the present North American Pacific Coast. Sliter (1968), dealing with foraminiferal faunas of early Maastrichtian age, postulated four marine climatic zones remarkably similar to those of the present. The molluscan equivalent of his south-central fauna includes such tropical forms as the rudist bivalve *Coralliochama* but would be equated to a modern warm temperate rather than a tropical fauna. Although the subgenus *Egelicalva* is of more northern distribution, its range probably extended south into the northern part of the warm temperate zone. The southern distributions of *Calva* (*E.*) *taffi* and C. (*E.*) *buttensis* are probably truncated by the lack of beds bearing *Calva* of early Senonian age south of Stanislaus Co. [17], California, and the northward distribution of C. (*E.*) *crassa* may also be more reflective of geologic preservation than original distribution. None of the faunas in which *Calva* is present appear to be truly tropical. But some, e.g., northern California Albian, Oregon Cenomanian, northern California Turonian, and southern California late Campanian, include a few genera of tropical aspect, suggesting that these were warm temperate faunas. If the distributions of *Calva* (*Calva*) spp. and *Calva* (*Egelicalva*) spp. are in part temperature dependent, the ranges in Figure 3 suggest a warm Turonian followed by a cooler Coniacian and Santonian. The late Campanian appears to have been slightly warmer than the early Campanian. The early Maastrichtian may have been the coolest interval, but it was followed by a considerable late Maastrichtian warming.

FEATURES MEASURED

In addition to the usual three measurements taken on bivalves, (1) valve height (H), measured perpendicular to the ligament, (2) valve length (L), measured parallel to the ligament, and (3) valve inflation (I), four other measurements were made: (1) distance from the beak to the anterior end (B); (2) lunule length (LL); (3) lunule width (LW); (4) the angle made by drawing lines through lateral teeth (LTA) AII and PII or sockets for AII and PII. The number of specimens measured ranged from only 2 specimens of C. (*Microcalva*) *elderi* to 16 of C. (*Egelicalva*) *taffi* and depended upon available specimens of sufficient completeness and the amount of time required to remove obscuring matrix. Figure 4 diagrams the features measured on specimens of *Calva*. Figure 5 compares ratios of these measurements and the angle through the lateral teeth. Although these measurements show specific differences, they provide no directional trends in these lineages.

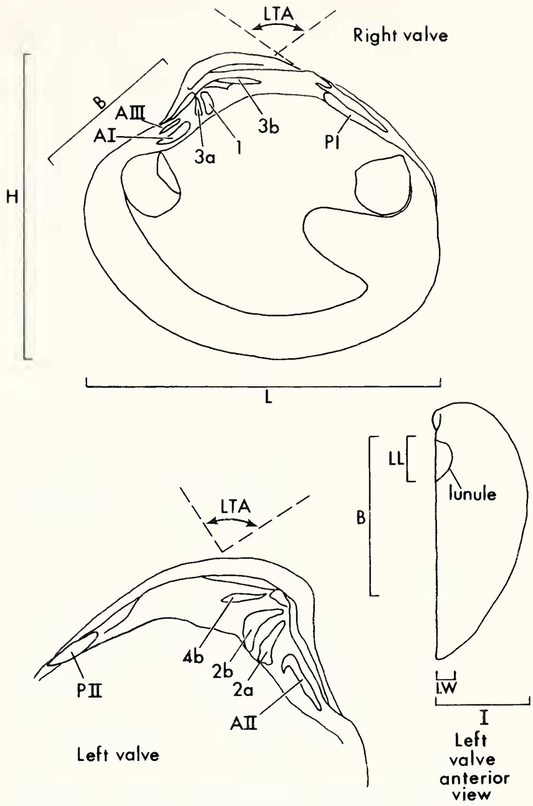


Figure 4. Diagrams of right valve interior view of *Calva* (*Penecallista*) *marina*, left valve anterior view of *Calva* (*Calva*) *peninsularis*, and left valve interior of *Calva* (*Egelicalva*) *crassa* with cardinal teeth labeled and measured features indicated. H, height measured perpendicular to the ligament; L, length measured parallel to the ligament; I, inflation of a single valve; B, distance from the beak to the anterior end; LL, length of the lunule; LW, width of the lunule; LTA, lateral tooth angle, the angle made by drawing a line through the sockets for the laterals AII and PII in the right valve or through the lateral teeth AII and PII in the left valve. Measurement LTA used as an alternative to beak angle, which is more difficult to measure consistently.

CHANGES IN *CALVA* THROUGH TIME

Most of the changes recognized between species appear undirected within lineages. Even size does not increase regularly. The largest species, *Calva* (*Calva*) *peninsularis*, C. (*Egelicalva*) *crassa*, and *Calva* (*Penecallista*) *marina*, are all of early Maastrichtian age. Some specimens of Cenomanian age C. (*E.*) *nitida* are larger than any known specimens of Turonian age C. (*E.*) *spissa*, Coniacian–Santonian age C. (*E.*) *taffi*, or early Campanian age C. (*E.*) *buttensis*; some specimens of late Campanian C. (*E.*) *bowersiana* approach the size of C. (*E.*) *crassa*. Late Maastrichtian *Calva* are of average size. Species of *Microcalva* are considerably smaller than are species of other subgenera of *Calva* and are comparable to *Microcallista* in size. *Calva* (*Calva*) *heliaca* of Cenomanian age and C. (*E.*) *taffi* of Coniacian–Santonian age are represented by smaller specimens than are other species of their lineages. Only in the hinge do some developmental trends appear. The anterior laterals become shorter and smoother, losing the striation of the early species. Cardinal tooth 1 moves dorsally from its early position at the hinge plate edge with its dorsal end ventral to that of 3a, whereas in later species its dorsal end is in a more beakward position than that of 3a, and its ventral end is no longer at the hinge plate edge. In C. (C.) *heliaca* cardinals 3a and 3b are connected dorsally by a low arched ridge; in later species this connection is broken as 1 moves into its more dorsal position.

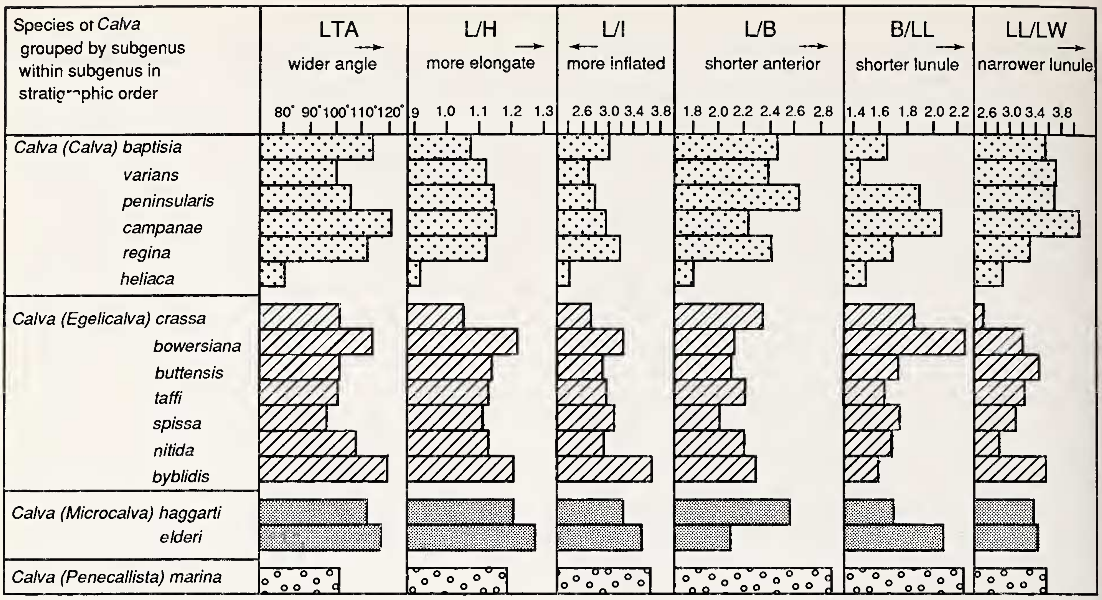


Figure 5. Ratios of measurements made on specimens of 16 species of *Calva*. Measurements from Tables 2–17. Features measured are described and abbreviations decrypted in Figure 4.

SUMMARY

Although for the past century *Venus varians* Gabb, 1864, and *Meretrix nitida* Gabb, 1864, have appeared on faunal lists from the same locality, they do not occur together and are not of the same age. These and 14 other species constitute the genus *Calva,* which is subdivided into four subgenera, two of which, *Calva* s.s. and *Egelicalva,* range through the Late Cretaceous of the Pacific Slope. Species of *Calva* are difficult to distinguish but can be discriminated and are diagnostic of discrete chronologic intervals.

Geographic distributions of *Calva* s.s. and *Calva* (*Egelicalva*), which result in *Egelicalva* having a more northerly distribution, suggest that terrane displacement was not equal to the latitudinal ranges of *Calva* s.l. species and that climatically there was a Coniacian–Santonian cooling, a warming in the late Campanian, and an early Maastrichtian cooling, followed by a warming through the late Maastrichtian.

Only the hinges of *Calva* display any evolving morphologic trends. The anterior lateral teeth become progressively smoother sided, and the central cardinal tooth of the left valve moves into a more beakward position.

ABBREVIATIONS

ANSP	Academy of Natural Sciences of Philadelphia
CAS	California Academy of Sciences, Golden Gate Park, San Francisco
CIT	California Institute of Technology (collections now housed at Natural History Museum of Los Angeles County)
CSMB	California State Mining Bureau
GSC	Geological Survey of Canada
LACMIP	Natural History Museum of Los Angeles County, Invertebrate Paleontology Section
SDSNH	San Diego Society of Natural History
SDSU	San Diego State University
SU	(= LSJU) Stanford University (collections now housed at the California Academy of Sciences, Golden Gate Park, San Francisco)
UCMP	University of California, Berkeley, Museum of Paleontology
UCLA	University of California, Los Angeles (collections now housed at Natural History Museum of Los Angeles County)
USGS	United States Geological Survey, Washington, D.C.
USGSM	United States Geological Survey, Menlo Park, California
USNM	United States National Museum

SYSTEMATIC PALEONTOLOGY

Phylum Mollusca Linnaeus, 1758
Class Bivalvia Linnaeus, 1758
Order Veneroida H. and A. Adams, 1856
Family Veneridae Rafinesque, 1815
Genus *Calva* Popenoe, 1937

TYPE SPECIES. By original designation *Calva regina* Popenoe, 1937, Turonian, Ladd Formation, Holz Shale Member, Santa Ana Mountains, California.

DIAGNOSIS. Veneriform bivalves having growth lines and, generally, well-marked growth checks and a depressed lunule set off by an incised line. Hinge with three cardinals in each valve, two anterior and two posterior lateral teeth in the right valve, and one anterior and one posterior lateral tooth in the left valve; posterior cardinal of the right valve 3b narrowly bifid; anterior lateral AII long, parallel to the lunular border, and terminated posteriorly in a short, ventrally directed prong; left posterior lateral a salient projection of the posterior dorsal margin fitting into an elongate socket in the right valve bounded dorsally by the right posterior dorsal shell margin, and ventrally by elongate lateral tooth PI. Nymphs smooth. Pallial sinus moderately deep. The anterior adductor muscle scar impressed and immediately at the anterior end of the hinge plate.

DISCUSSION. In *Calva,* the posterior lateral tooth of the left valve is not set on the hinge plate but is instead a salient portion of the valve margin that fits into the well-developed posterior lateral socket of the right valve. This tooth is not obvious in plane view but is noticeable in profile as a triangular extension of the valve margin. The dorsal or outer posterior lateral of the right valve is also on the valve margin, and as it is not clearly distinguished from the valve margin, an argument could be made for recognizing only the one posterior lateral interior to the lateral socket. Casey (1952) has, as have we, considered that the clasping structures of the right valve are both posterior lateral teeth even if the exterior one is on the valve margin. Popenoe (1937) noted that posterior laterals are a rare feature in venerid shells, but they are common in Jurassic and Early Cretaceous arcticid precursors of the venerids (Casey, 1952). Posterior laterals are present in some Cretaceous venerids, e.g., *Resatrix* Casey, 1952, *Pseudaphrodina* Casey, 1952, *Trigonocallista* Rennie, 1930, *Loxo* Dailey and Popenoe, 1966, and *Calva* Popenoe, 1937, and in the Late Cretaceous–early Tertiary *Dosiniopsis* Conrad, 1864. Posterior laterals, thus, seem to be a feature derived by venerids from their arcticid ancestors and dispensed with in various lineages through the Cretaceous. The impetus for the removal of the posterior laterals may lie in the need to burrow faster. Strong posterior laterals would inhibit the rocking action of the valves that has been shown to assist burrowing (Trueman et al., 1966).

Sufficiently well-preserved individuals of all species of *Calva* display regularly spaced, fine concentric grooves on the beak area. These grooves rarely extend beyond the first prominent growth check.

Two lineages of *Calva* can be recognized in Pacific Slope deposits. The typical lineage comprises *C. heliaca, C. regina, C. campanae, C. peninsularis, C. varians,* and *C. baptisia.* All have a slightly to moderately arched hinge plate in which the major flexure is posterior to posterior cardinal tooth 3b. The hinge plate is relatively broad, and the lunule is moderately impressed and of moderate width. Posterior lateral PI of the right valve stands high enough to extend beyond the plane of commissure and bounds a relatively broad socket for PII. The lineage, herein assigned to the new subgenus *Egelicalva,* comprises *C. byblidis, C. nitida, C. spissa, C. taffi, C. buttensis, C. bowersiana,* and *C. crassa.* All are of medium to large size and have a lunule that is relatively wider and more deeply impressed than that of *Calva* s.s. They have hinge plates that are relatively narrow and moderately to well arched in which the major flexure is between cardinals 1 and 3b. Species of Albian–early Campanian age have laterals that are more coarsely striated than those of the typical lineage. Additionally, three other subgenerically distinct species are present. Two of these, *Calva elderi* and *C. haggarti,* have small shells displaying fine, round-topped concentric ribs and a small depressed lunule; *Calva haggarti* typifies the new subgenus *Microcalva. Calva* (*Penecallista*) *marina* has a large shell resembling a *Callista* Poli, 1791; its anterior lateral is shorter than that of other *Calva* spp., and it typifies the new subgenus *Penecallista.*

Popenoe (1937) described *Calva* as having smooth laterals, and Casey (1952, p. 172), who examined specimens sent to him by Popenoe, also stated that the anterior lateral teeth and sockets are smooth, not striated. Popenoe (1940) had recognized *Trigonocallista* Rennie, 1930, as the senior synonym of *Calva,* but Casey (1952) considered the genera distinct because *Calva* has smooth laterals, whereas those of *Trigonocallista* are striate. However, at 20× magnification the anterior lateral AII of *C. regina* is finely striate on its dorsal side; PI is finely striate on its dorsal side; and both sides of the socket for AII are finely striate. Striae are unrecognizable on the laterals of late Campanian and younger species of *Calva.* In *Trigonocallista umzambiensis* (Woods, 1906) from the Umzamba Formation of Santonian–early Campanian age (Klinger and Kennedy, 1980), however, the laterals are coarsely striate. According to Keen (*in* Moore, 1969, p. N679) cardinal 3b of *Trigonocallista* is entire, but Rennie (1930) described it as superficially grooved, and illustrations show it narrowly bifid. *Calva* bears a strong resemblance to *Trigonocallista* Rennie, 1930, but *Trigonocallista* has the anterior laterals curved and subparallel to the lunular margin, the nymph border wrinkled, a shallow pallial sinus, and a distinctly demarked escutcheon. The more coarsely striated anterior laterals of pre-Campanian species of the subgenus *Egelicalva* are suggestive of *Trigonocallista,* but the escutcheon of *Egelicalva* is less well defined than that of *Calva* s.s. and much less well defined than that of *Trigonocallista.* The anterior lateral of *Calva* is hooked. It parallels the lunular margin but is straight and has at its dorsal end a short, abruptly inward turned prong. The resultant angle faces toward the interior of the shell. The anterior lateral of *Trigonocallista* is arched but not hooked. The portion of the hinge plate bearing the anterior laterals is narrow, whereas in *Calva* this portion of the hinge plate is much broader. The posterior lateral socket of *Calva* is wider and deeper than that of *Trigonocallista.*

Trigonocallista has more in common with the Late Cretaceous–early Tertiary genus *Dosiniopsis* Conrad, 1864, than either have with *Calva*. Both these Atlantic Basin venerids have conspicuously striated laterals and rugose nymphae.

According to Casey (1952, p. 173) the earliest stratigraphic record of *Calva* s.s. is the British upper Albian species *Calva subrotundata* (J. de C. Sowerby, 1836). *Calva subrotundata* is very similar to Pacific Slope *Calva* but has a better defined escutcheon and, judging from Woods' (1908, pl. 28, figs. 1–6) illustrations, lacks the posterior hook on the anterior lateral AII. Casey (1952) derives *Calva* from *Dosiniopsella* Casey, 1952, of early and middle Albian age by way of *Chimela* Casey, 1952, of late Albian age, which he considers to be a subgenus of *Calva*. *Chimela* does not have the lunule in a depressed area, and the anterior lateral AII does not appear to be hooked. Casey (1952, fig. 93) does not draw an inscribed lunule on *Calva* (*Chimela*) *caperata* (J. de C. Sowerby, 1836), but Woods (1908, pl. 28, figs. 7–10) shows one. Both *C. subrotundata* and *C.* (*Chimela*) *caperata* are more like *Dosiniopsella* than is the earliest Pacific Slope *Calva*, *C.* (*Egelicalva*) *byblidis* of late early Albian age. The latter has a hooked anterior lateral rather than the convexly arched lateral of *Dosiniopsella*. The posterior right cardinal of *C.* (*E.*) *byblidis* is narrowly bifid; the posterior arm is decidely the longer and in echelon to the shorter anterior arm, a condition not found in *Dosiniopsella*. These differences suggest that although *Calva* may be derived from *Resatrix* Casey, 1952, the ancestor of *Dosiniopsella*, it was probably not derived from *Resatrix* by way of *Dosiniopsella* and *Chimela*.

Calva is recognized with certainty only in Pacific Slope deposits from Alaska to Baja California Sur, Mexico, of early Albian to late Maastrichtian age.

Subgenus *Calva* Popenoe, 1937

DIAGNOSIS. Species of *Calva* of subquadrate shape having an apparent posterior truncation and smooth exterior except for growth lines and growth checks. Hinge plate relatively broad and slightly arched with maximum flexure posterior to cardinal 3b; posterior lateral PI realtively short and high. Pallial sinus broad with steeply ascending ventral arm and nearly horizontal dorsal arm.

Calva (*Calva*) *heliaca*, new species

Figures 6–19

DIAGNOSIS. A very high, short, thick-shelled *Calva*.

DESCRIPTION. Shell thick, of moderate size, higher than long, inflated, with subdued posterior angulation; beaks prominent, anterior to the midlength of the shell, prosogyrous, lunular margin convex; anterior end rounded; ventral border arched; posterior end bluntly truncate vertically; posterior dorsal border long, slightly arched; lunule heart-shaped, relatively large, moderately deep, delimited by an inscribed line; escutcheon long, obscurely demarked by rounded angulation.

Ligament groove relatively short, arched behind strong nymphs. Hinge of right valve with anterior tooth 3a and median cardinal tooth 1 short but sturdy, 3a closer to the beak than 1 and joined to 3b by a low arched ridge dorsal to 1, ventral end of 1 at the hinge plate margin; posterior cardinal 3b bifid, long, subparallel to the nymph; AIII low, elongate, obscurely separated from valve margin by shallow groove; AI low, elongate, with a prominence at beakward end; socket for lateral AII very long, rather wide, deep, parallel to the lunular border of the shell, finely striate on both sides; socket for PII moderately deep, bounded below by large projecting tooth PI; PI finely striate on dorsal side. Hinge of left valve with anterior cardinal 2a very slender; cardinal 2b trigonal, sturdy; posterior cardinal 4b elongate, separated from the nymph by a shallow groove; anterior lateral AII long, heavy, parallel to lunular valve margin, posteriorly hooked, finely striate on dorsal side; posterior lateral tooth PII a salient portion of the shell-margin just posterior to the posterior end of the nymph. Pallial sinus and muscle scars unknown.

HOLOTYPE. LACMIP cat. no. 8200.

PARATYPES. LACMIP cat. nos. 8201–8204 from LACMIP loc. 28788, north of Sunflower Valley, Kings Co.; USNM cat. no. 456070 from USGS loc. M8573, Garza Peak Quadrangle, Kings Co. [20], California.

TYPE LOCALITY. LACMIP loc. 28788, north of Sunflower Valley, Reef Ridge Quadrangle, Kings Co. [20], California.

GEOLOGIC AGE. Cenomanian.

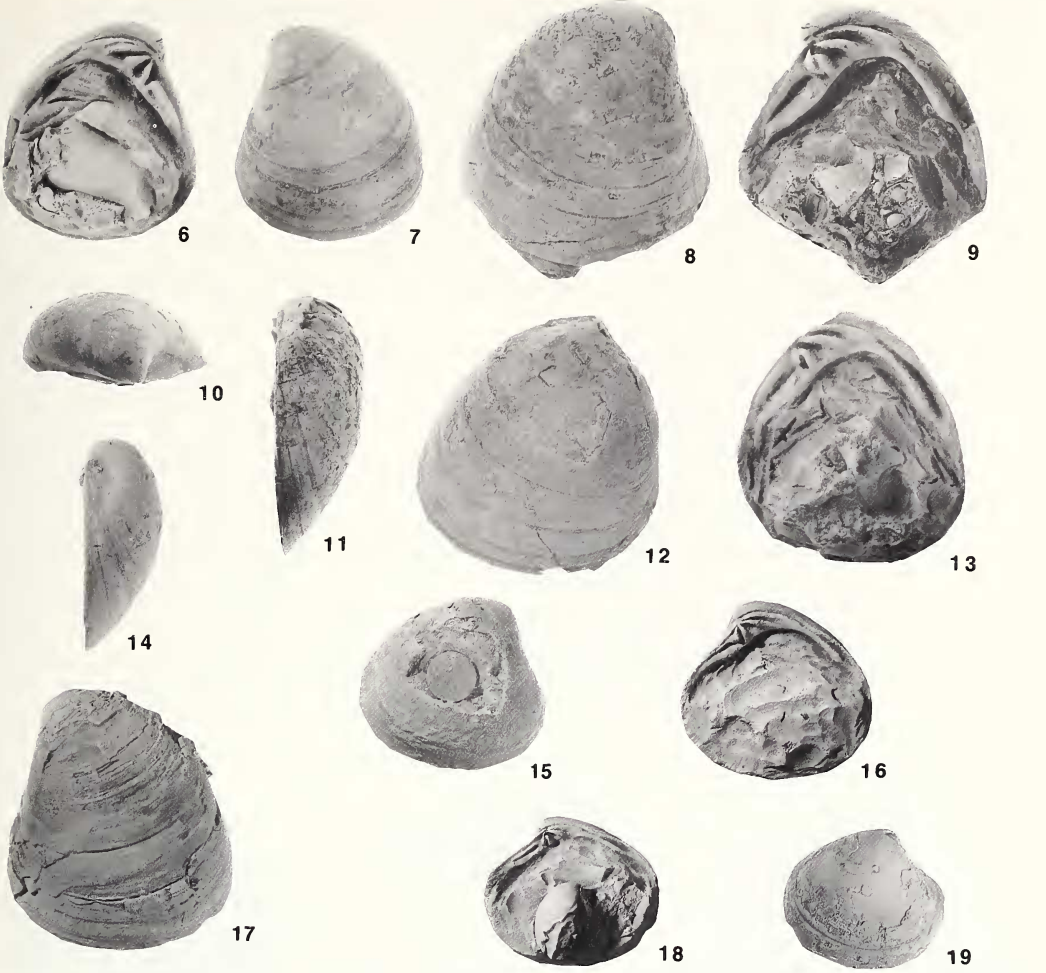
DISTRIBUTION. Boulders in a Panoche Formation conglomerate that crops out between Big Tar Canyon and Sunflower Valley, Kings Co. [20], California; Valle Formation, northern Vizcaíno Peninsula [33], Baja California Sur, Mexico.

DIMENSIONS. See Table 2.

REMARKS. *Calva heliaca* is tentatively included in *Calva* s.s. because of the very fine striations on its lateral teeth, relatively short, high PI, and bluntly truncated posterior. Within *Calva* s.s., *C.* (*C.*) *heliaca*'s attached 3a and 3b and distant 1 give it the most primitive hinge. It differs from other *Calva* s.s. in having the hinge plate strongly arched and from all other known *Calva* in being higher than long. Small specimens are relatively elongate and proportioned like other *Calva*, but those over 25 mm in length are higher than long. *Calva* (*C.*) *heliaca* resembles *C.* (*Egelicalva*) *taffi* in shape but is relatively higher, has a more bluntly truncated posterior, and has longer, stronger anterior lateral teeth.

At its type locality in redeposited boulders in a Panoche Formation conglomerate, *Calva* (*C.*) *heliaca* is associated with *Anthonya cultriformis* Gabb, 1864, and *Nelltia roddana* Saul, 1973, both indicative of Cenomanian age.

ETYMOLOGY. The species name, derived from



Figures 6–19. *Calva* (*Calva*) *heliaca,* new species. All ×1; all specimens whitened with ammonium chloride. **6, 7, 10, 14,** LACMIP cat. no. 8200, holotype, from LACMIP loc. 28788; **6,** hinge, **7,** exterior, **10,** dorsal view, **14,** anterior view. **8, 9,** LACMIP cat. no. 8201, paratype, from LACMIP loc. 28788, **8,** exterior, **9,** hinge. **11–13,** LACMIP cat. no. 8202, paratype, from LACMIP loc. 28788, **11,** posterior view, **12,** exterior, **13,** hinge. **15, 16,** LACMIP cat. no. 8154, paratype, from UCLA loc. 6973, **15,** exterior, **16,** hinge. **17,** USNM cat. no. 456070, paratype, from USGS loc. M8573, exterior. **18, 19,** LACMIP cat. no. 8203, paratype, from LACMIP loc. 28788, **18,** hinge, **19,** exterior. Photos 6–14 by Saul; 15–19 by De Leon.

Greek, *helios,* sun, refers to the type locality north of Sunflower Valley.

Calva (*Calva*) *regina* Popenoe, 1937

Figures 20–29

Calva regina Popenoe, 1937, p. 395, pl. 48, figs. 6–7, 13–14; Popenoe, 1954, fig. 4 (8); Keen *in* Moore, 1969, p. N677, fig. E145, 1a–1c; Jones, Sliter, and Popenoe, 1978, pl. 2, fig. 32.

Trigonocallista regina (Popenoe) Popenoe, 1940, p. 163; Anderson, 1958, p. 140.

DIAGNOSIS. A *Calva* with a subdued posterior angulation, strong posterior truncation, slightly concave lunular margin, and finely striated lateral teeth.

DESCRIPTION. Shell moderately thick, of moderate size, nearly as high as long, inflated, having a subdued posterior angulation; beaks prominent, anterior to the mid-length of the shell, prosogyrous; lunular margin slightly concave; anterior end sharply rounded; ventral border broadly arched; posterior end bluntly truncate vertically; posterior dorsal border moderately short, slightly arched; lunule heart-shaped, moderately large, deep, delimited by an inscribed line; escutcheon moderately wide, smooth, demarked by rounded angulation.

Ligament groove arched behind moderate nymphs. Hinge of right valve with anterior tooth 3a and median cardinal tooth 1 short, narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; posterior

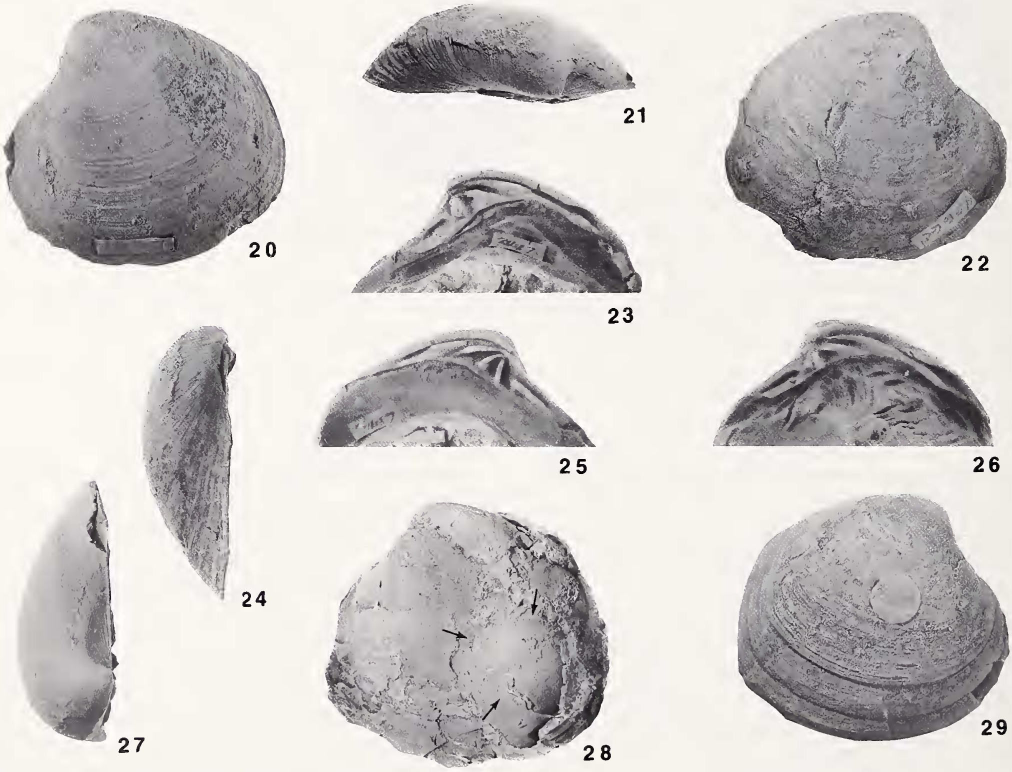
Table 2. Measurements of *Calva* (*Calva*) *heliaca*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 8154	22.8	24.6		12.5	8.5	2.5	100°	1.1	—	2.0	1.5	3.4
LACMIP 8200	27.8	25.0	10.5	15.5	9.6	3.6	78°	0.9	2.4	1.6	1.6	2.7
LACMIP 8201	37.5	32.4	15.7	18.8	12.6	4.7	75°	0.9	2.1	1.7	1.5	2.7
LACMIP 8202	33.7	31.1	12.4	16.6	11.8	3.9	75°	0.9	2.5	1.9	1.4	3.0
LACMIP 8203	19.0	22.4	7.5	9.8	6.2	2.8	105°	1.2	3.0	2.3	1.6	2.2
USNM 456070	37.0	32.8	13.7	20.0	13.5	4.8	80°	0.9	2.4	1.6	1.5	2.8

cardinal 3b long, straight, shallowly bifid subparallel to the nymph; socket for lateral AII long, narrow, moderately deep, parallel to the lunular border of the shell, finely striate on both sides; socket for PII deep, bounded below by rather large projecting tooth PI; PI finely striate on dorsal side. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; cardinal 2b thicker than 2a, trigonal, directed posteriorly; posterior cardinal 4b slightly longer than the anterior teeth, slender; anterior lateral AII long, parallel to lunular valve margin, posteriorly hooked, finely striate on dorsal side; posterior lateral tooth PII a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broad, rounded, extending about to mid valve length; dorsal arm convex, almost horizontal; ventral arm arcuate, steeply ascending. Adductor muscle scars lightly impressed; anterior oval; posterior round.

SYNTYPES. UCLA cat. nos. 40660–40661 (ex CIT cat. no. 3447). UCLA 40661 was figured inadvertently as the holotype by Jones et al. (1978, pl. 2, fig. 32).

HYPOTYPES. LACMIP cat. nos. 8205 from UCLA loc. 2323, Santa Ana Mts. [26]; 8206 from



Figures 20–29. *Calva* (*Calva*) *regina* Popenoe. All ×1; all specimens whitened with ammonium chloride. **20, 21, 24, 25, 27,** UCLA cat. no. 40661, syntype, from CIT loc. 1164, **20,** exterior, **21,** dorsal view, **24,** posterior view, **25,** hinge, **27,** anterior view. **22, 23,** UCLA cat. no. 40660, syntype, from CIT loc. 1164, **22,** exterior, **23,** hinge. **26, 29,** LACMIP cat. no. 8205, hypotype, from UCLA loc. 2323, hinge, **29,** exterior. **28,** LACMIP cat. no. 8206, hypotype, from LACMIP loc. 10135, pallial sinus. Photos 20, 21, 23, 28, 29 by De Leon; 22, 24–27 by Saul.

Table 3. Measurements of *Calva* (*Calva*) *regina*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/LW
UCLA 40660	33.7	38.0	10.3	16.0	9.5	3.0	109°	1.1	3.7	2.4	1.7	3.2
UCLA 40661	33.0	37.0	11.7	14.8	10.0	3.0	112°	1.1	3.2	2.5	1.5	3.3
LACMIP 8205	33.5	36.5	13.5	19.4	10.8	3.0	118°	1.1	2.7	1.9	1.8	3.6

LACMIP loc. 10135, Santa Ana Mts. [26], Orange Co., California.

TYPE LOCALITY. CIT loc. 1164, south side of Silverado Canyon opposite Holz Ranch house [26], Santa Ana Mts., Orange Co., California.

GEOLOGIC AGE. Turonian; associated with *Subprionocyclus neptuni* (Geinitz).

DISTRIBUTION. Ladd Formation, sandstone beds in the Baker Canyon Conglomerate Member, Santa Ana Mts. [26], Orange Co., California; Valle Formation, Cedros Island [32], Baja California Sur, Mexico.

DIMENSIONS. See Table 3.

REMARKS. *Calva* (*C.*) *regina* is thinner shelled, has a narrower hinge plate and a subdued angulation delimiting the escutcheon, and is more quadrate than the contemporaneous *C.* (*Egelicalva*) *spissa* with which it has been confused. *C.* (*C.*) *regina* is shorter and has a narrower, more arched hinge plate than *C.* (*C.*) *campanae.* The laterals of *C.* (*C.*) *regina* are finely striate, but those of *C.* (*C.*) *campanae* and geologically younger species of *Calva* s.s. are smooth. In overall shape *C.* (*C.*) *regina* is most like *C.* (*C.*) *peninsularis,* but all specimens of *C.* (*C.*) *regina* are smaller than average sized *C.* (*C.*) *peninsularis.* The specimens of *C.* (*C.*) *regina* figured by Popenoe (1937) are, however, relatively small, and specimens twice as large are common but usually crushed or broken. *Calva* (*C.*) *regina* is less inflated and has a more subdued posterior angulation and a larger lunule than *C.* (*C.*) *peninsularis. Calva* (*C.*) *varians* is more inflated and trigonal than *C.* (*C.*) *regina,* and *C.* (*C.*) *baptisia* has cardinal 4b longer than lateral AII.

Calva (*Calva*) *campanae,* new species

Figures 30–49

DIAGNOSIS. A relatively elongate *Calva* with straight lunular margin, weak posterior angulation, nearly straight hinge plate, and smooth laterals.

DESCRIPTION. Shell moderately thick, of moderate size, longer than high, moderately inflated; beaks prominent but low, anterior to the midlength of the shell, prosogyrous; lunular margin straight; anterior end rounded; ventral border broadly arched; posterior end bluntly truncate vertically; posterior dorsal border moderately short, slightly arched; lunule heart-shaped, moderately large, delimited by an inscribed line; escutcheon narrow, smooth, demarked by subdued angulation.

Ligament groove arched behind moderate nymphs. Hinge of right valve with anterior tooth 3a and median cardinal tooth 1 short, narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; posterior cardinal 3b long, straight, shallowly bifid subparallel to the nymph; socket for lateral AII long, narrow, moderately deep, parallel to the lunular border of the shell; socket for PII deep, bounded below by a rather large projecting tooth PI. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; cardinal 2b thicker than 2a, trigonal, directed posteriorly; posterior cardinal 4b slightly longer than the anterior teeth, slender; anterior lateral AII long, parallel to lunular valve margin, posteriorly hooked; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broad, bluntly angulate, extending across two-fifths the valve length; dorsal arm nearly straight, horizontal; ventral arm slightly arcuate, steeply ascending.

HOLOTYPE. LACMIP cat. no. 8207.

PARATYPES. LACMIP cat. nos. 8208 from LACMIP loc. 10710, Bell Canyon [24]; 8209 from UCLA loc. 6020, Bell Canyon [24]; 8210–8212 from LACMIP loc. 10709, Bell Canyon [24]; 8213–8215 from UCLA loc. 6232, Bell Canyon [24], Simi Hills, Ventura Co.; 8216–8217 from LACMIP loc. 10096, Santa Ana Mts. [26], Orange Co., California.

HYPOTYPE. LACMIP cat. no. 8218 from LACMIP loc. 11944, Vizcaíno Peninsula [34], Baja California, Mexico.

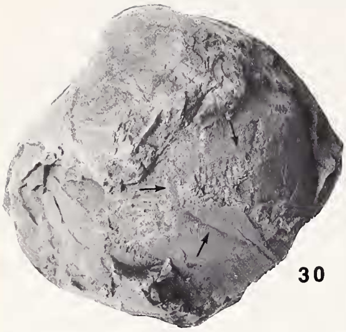
TYPE LOCALITY. LACMIP loc. 10710, Bell Canyon, Ventura Co. [24], California.

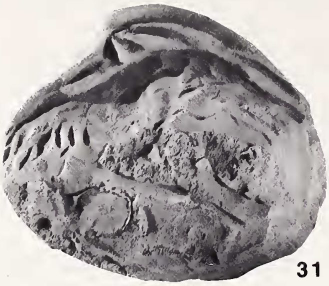
GEOLOGIC AGE. Mid and late Campanian.

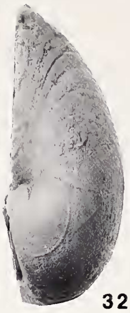
DISTRIBUTION. Chatsworth Formation, Bell Canyon [24], Simi Hills, Ventura Co.; Uppermost Holz Shale Member of the Ladd Formation and Pleasants Sandstone Member of the Williams Formation, Santa Ana Mts., Orange Co. [26], California. Valle Formation, Vizcaíno Peninsula [34], Baja California Sur, Mexico.

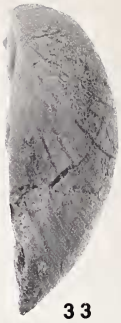
DIMENSIONS. See Table 4.

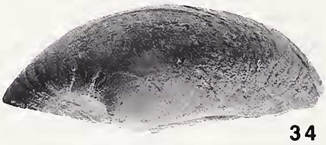
REMARKS. *Calva* (*C.*) *campanae* has commonly been misidentified as *C.* (*Egelicalva*) *bowersiana* (Cooper). It is, however, generally smaller with a lower beak and has a relatively heavier hinge and a less depressed lunule. The ventral margin of the hinge plate of *C.* (*C.*) *campanae* is nearly straight from the ventral end of the posterior cardinal to the anterior end of the anterior cardinal, but in *C.* (*E.*) *bowersiana* the ventral margin of the hinge

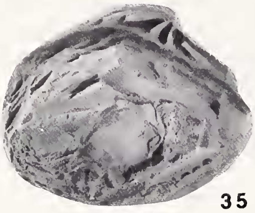

30

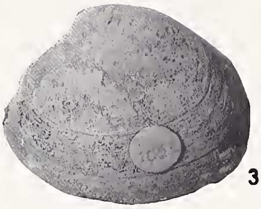

31

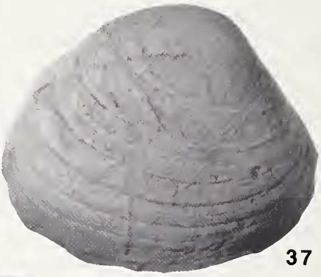

32

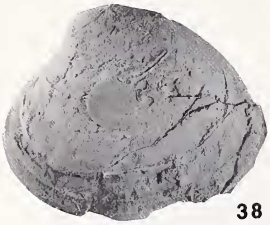

33

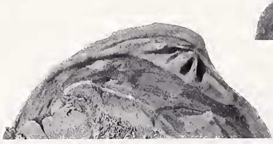

34

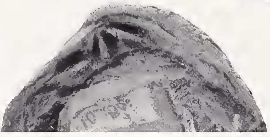

35

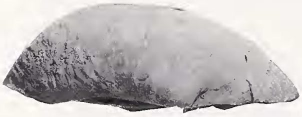

36

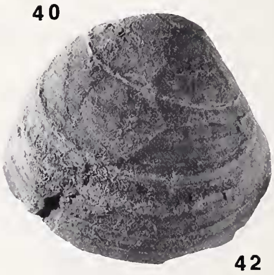

37

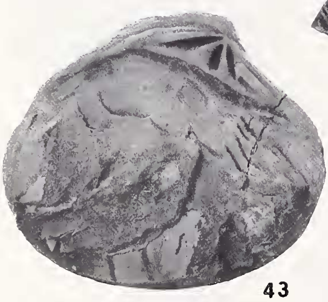

38

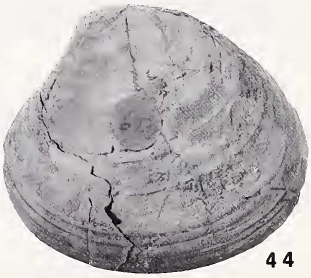

39

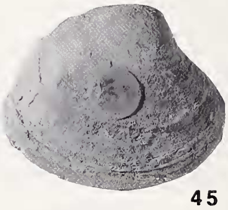

40

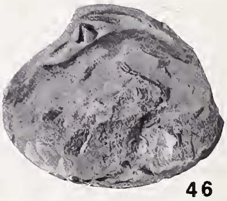

41

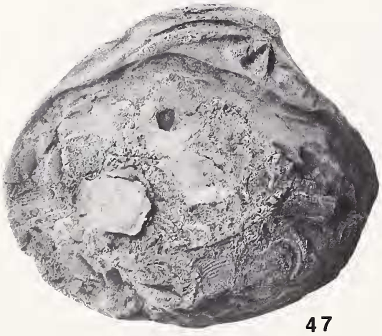

42

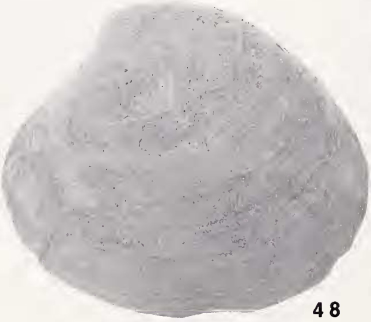

43


44


45


46


47


48

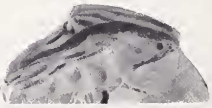

49

Table 4. Measurements of *Calva* (*Calva*) *campanae*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/LW
LACMIP 8207	37.0	44.1	15.0	18.9	9.7	3.7	118°	1.2	2.9	2.3	1.9	2.6
LACMIP 8208	41.8	47.8	13.5	22.2	9.5	2.0	114°	1.1	3.5	2.2	2.3	4.8
LACMIP 8210	32.0	34.7	12.5	15.8	8.2	3.3	102°	1.1	2.8	2.2	1.9	2.5
LACMIP 8211	35.4	33.7	17.0	15.7	8.8	3.0		1.0	2.0	2.1	1.8	2.9
LACMIP 8213	35.4	40.0	15.8	18.2	11.4	2.5	120°	1.1	2.5	2.2	1.6	4.6
LACMIP 8214	29.0	35.3	12.3	15.9	15.9	1.6	120°	1.2	2.9	2.2	1.0	9.9
LACMIP 8216	25.7	32.0	10.4	16.5	6.4	1.8	120°	1.2	3.1	1.9	1.3	3.6
LACMIP 8217	19.8		7.8	10.8	4.7	1.0	120°	—	—	—	2.3	4.7

plate is arched. The anterior cardinal is relatively shorter than that of *C.* (*E.*) *bowersiana* but not as short as that of *Loxo decore* Dailey and Popenoe, 1966; unlike that of *L. decore,* the anterior lateral parallels the valve margin. The socket for 3b is relatively wider than that in *C.* (*E.*) *bowersiana,* and the posterior end of the anterior lateral is between the ventral end of 2a and the valve margin.

Calva (*C.*) *campanae* is more elongate and more inflated and has a broader, less arched hinge plate and a weaker posterior angulation than *Calva* (*C.*) *regina. Calva* (*C.*) *campanae* has a straighter hinge plate, and a broader lunule and lacks the distinctive angulation of *C.* (*C.*) *peninsularis.*

A large left valve, CAS cat. no. 66296.01, from "6 miles north of Rosario Canyon," Baja California, Mexico, may belong to this species, although no other specimen of *Calva* (*C.*) *campanae* approaches its length of 75 mm. The specimen is broken around the ventral margin and was probably at least 10 mm longer. The margin that would provide the posterior lateral is missing as is the posterior cardinal tooth 4b. The specimen also resembles *C.* (*C.*) *varians* but is larger than most specimens of *C.* (*C.*) *varians* and its anterior lateral is closer to the beak. It is comparable in size to *C.* (*Egelicalva*) *crassa* but has a straighter hinge line, the anterior lateral closer to the beak, and a less concave lunule. If this specimen is indeed *C.* (*C.*) *campanae* and the locality information is acurate, this is the first indication that beds of mid to late Campanian age crop out that far north of El Rosario.

ETYMOLOGY. The species is named for its type locality in Bell Canyon, *campana,* Latin, bell.

Calva (*Calva*) *peninsularis* (Anderson and Hanna, 1935)

Figures 50–66

Corbis peninsularis Anderson and Hanna, 1935, p. 31, pl. 10, fig. 1.

Corbis sp. aff. *C. peninsularis* Anderson and Hanna, Moore, 1968, p. 22, pl. 9a.

Trigonocallista sp., Sundberg, 1979, p. 176, pl. 1, fig. 9.

Calva sp., Sundberg and Riney, 1984, p. 104, fig. 2 (11).

DIAGNOSIS. A rounded *Calva* with slightly concave lunular margin, a posterior angulation, and smooth lateral teeth.

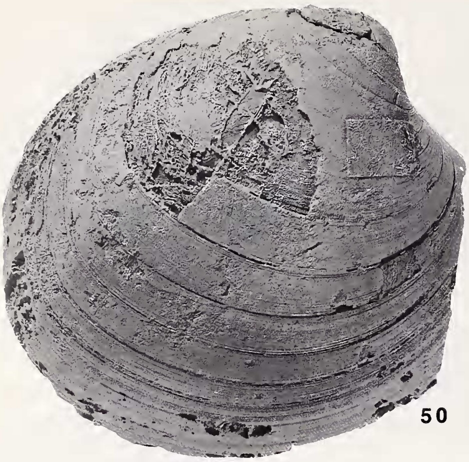
DESCRIPTION. Shell of moderate size, nearly as high as long, inflated, rather thick, having a posterior angulation extending from beak to posteroventral border; beaks prominent, rather high, placed anterior to the mid-length of the shell, prosogyrous; lunular margin slightly concave; anterior end rather sharply rounded; ventral border broadly arched; posterior end bluntly truncate vertically; posterior dorsal border of moderate length, slightly arched; lunule relatively small, deep, delimited by an inscribed line; escutcheon demarked by rounded angulation.

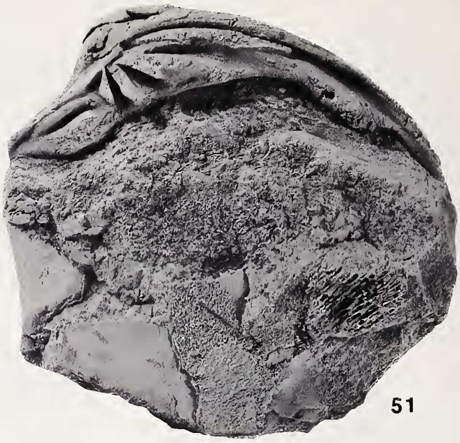
Ligament groove arched behind moderate nymphae. Hinge of right valve with anterior tooth 3a very short and median cardinal tooth 1 short, narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; 1 extending from very near the hinge plate edge to as

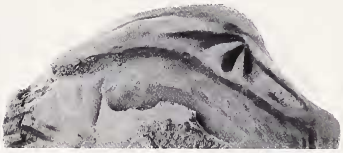
---

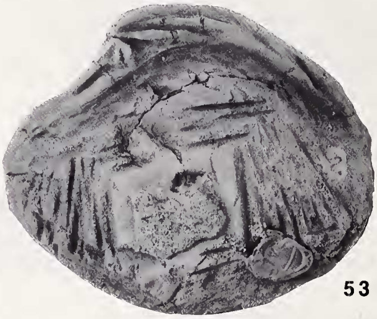
←

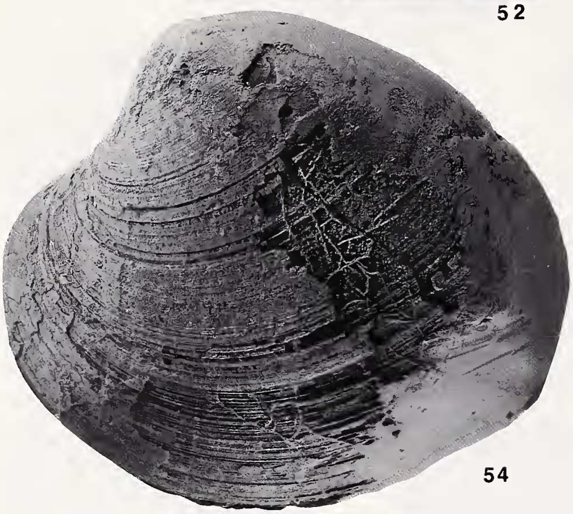
Figures 30–49. *Calva* (*Calva*) *campanae,* new species. All ×1; except as indicated, all specimens whitened with ammonium chloride. **30,** LACMIP cat. no. 8209, paratype, from UCLA loc. 6020, pallial sinus, without whitening. **31–34, 37,** LACMIP cat. no. 8207, holotype, from LACMIP loc. 10709, **31,** hinge, **32,** anterior view, **33,** posterior view, **34,** dorsal view, **37,** exterior. **35, 36,** LACMIP cat. no. 8216, paratype, from LACMIP loc. 10096, **35,** hinge, **36,** exterior. **38, 39,** LACMIP cat. no. 8214, paratype, from UCLA loc. 6232, **38,** exterior, **39,** hinge, **40, 42, 43,** LACMIP cat. no. 8210, paratype, from LACMIP loc. 10709, **40,** hinge, **42,** exterior, **43,** hinge. **41, 44,** LACMIP cat. no. 8213, paratype, from UCLA loc. 6232, **41,** dorsal view, **44,** exterior. **45, 46,** LACMIP cat. no. 8215, paratype, from UCLA loc. 6232, **45,** exterior, **46,** hinge. **47, 48,** LACMIP cat. no. 8208, paratype, from LACMIP loc. 10709, **47,** hinge, **48,** exterior. **49,** LACMIP cat. no. 8217, paratype, from LACMIP loc. 10096, hinge. Photos 30, 32, 33, 40, 43, 44, 47, 48 by Saul; 31, 34–39, 41, 42, 45, 46, 49 by De Leon.

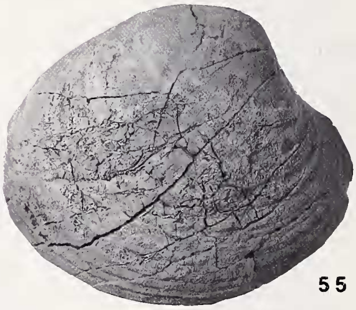

50

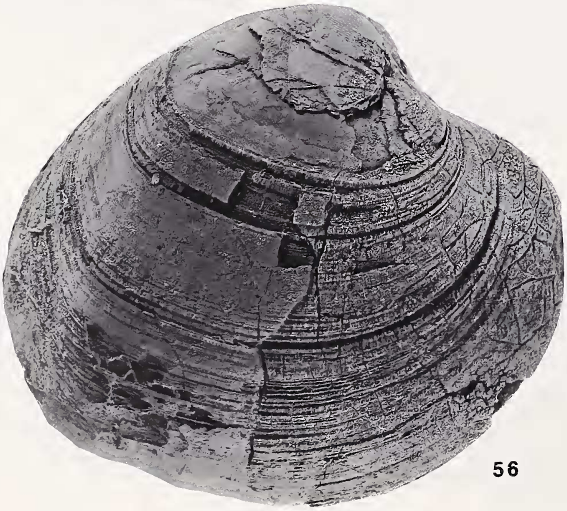

51

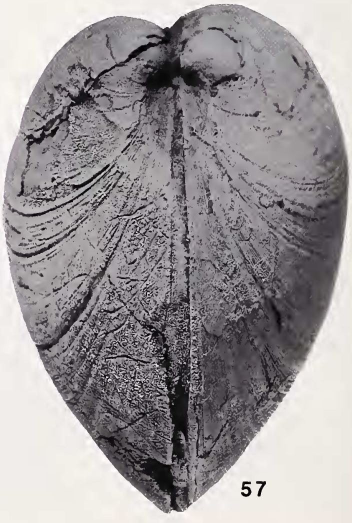

52


53


54


55


56


57

close to beak as 3a; posterior cardinal 3b long, straight, shallowly bifid subparallel to the nymph; socket for lateral AII long, narrow, moderately deep, smooth, parallel to the lunular border of the shell; socket for PII deep, bounded below by a rather large projecting tooth. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; cardinal 2b thicker than 2a, trigonal, directed obliquely backward; posterior cardinal 4b continuous with the ventral side of the nymph, slightly longer than the anterior teeth, not very massive; anterior lateral AII long, wedge-shaped, parallel to the hinge border below the lunule, smooth sided; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broad, bluntly angulate, extending about to the posterior valve quarter length, arms nearly equal; dorsal arm slightly descending; ventral arm steeply ascending, slightly concave. Anterior adductor scar deeply set, semicircular; posterior adductor scar lightly impressed, rather round.

HOLOTYPE. UCMP cat. no. 36119.

HYPOTYPES. CAS cat. no. 66512.01 from CAS loc. 66512, Point Loma [28], San Diego Co.; SDSNH cat. no. 25994 from SDSNH loc. 3162-A, Carlsbad Research Center [27], San Diego Co.; LACMIP cat. nos. 7746 from LACMIP loc. 22629 (= SDSU loc. 6), La Jolla [28], San Diego Co.; 8219–8220 from UCLA 2415, Bee Canyon [26], El Toro Quadrangle, Orange Co., California; 8221 from LACMIP loc. 2855, Arroyo Santa Catarina [31]; 8222 from LACMIP loc. 5989, Arroyo Santa Catarina [31]; 8223–8224 from UCLA loc. 3268, Arroyo Santa Catarina [31]; UCMP cat. no. 38658 from UCMP loc. A-467, north of San Antonio del Mar [30], Baja California, Mexico.

TYPE LOCALITY. UCMP loc. A-467, 6.5 miles [10.4585 km] north of San Antonio del Mar [30], Baja California, Mexico.

GEOLOGIC AGE. Latest Campanian and early Maastrichtian.

DISTRIBUTION. Panoche Formation on Los Gatos Creek [19], Fresno Co., California; Williams Formation, Pleasants Sandstone at Bee Canyon [26], Santa Ana Mts., Orange Co., California; basal Point Loma Formation at La Jolla [28], and reworked into Cabrillo Formation on Point Loma [28], San Diego Co., California; Rosario Formation at Punta Banda [29], near San Antonio del Mar [30], and Arroyo Santa Catarina [31], Baja California, Mexico.

DIMENSIONS. See Table 5.

REMARKS. Anderson and Hanna (1935) did not describe a hinge for this species. The hinge of the holotype was exposed by W. P. Popenoe permitting a more appropriate familial and generic assignment. The posterior angulation readily distinguishes *Calva* (*C.*) *peninsularis* from all other species of *Calva*. It is less elongate than *C.* (*C.*) *varians,* more inflated than *C.* (*C.*) *campanae,* and smaller but more inflated than *C.* (*Penecallista*) *marina* and does not have as deep a lunule as *C.* (*Egelicalva*) *crassa.* It resembles *C.* (*C.*) *regina* but has smooth laterals.

In the Panoche Formation on the north side of Los Gatos Creek [19], Fresno Co., *Calva* (*C.*) *peninsularis* occurs in beds just below those yielding *Pachydiscus* (*Neodesmoceras*) cf. *P.* (*N.*) *catarinae* (Anderson and Hanna, 1935) and well above strata that yield *Metaplacenticeras* sp. At Bee Canyon [26], El Toro Quadrangle, Orange Co., specimens intermediate between *C.* (*C.*) *campanae* and *C.* (*C.*) *peninsularis* (Figs. 52, 53, 55) occur with compressed, fine-ribbed, tricarinate *Metaplacenticeras pacificum* (Smith, 1900). These *Metaplacenticeras* resemble the holotype of *M. pacificum,* and this typical morph is the youngest of the Pacific Slope forms that have commonly been referred to the *Metaplacenticeras pacificum* Zone (John Alderson, pers. communication).

Corbis aff. *Calva peninsularis* Anderson and Hanna, *in* Anderson, 1958 (p. 58), from CAS loc. 28118, Quinto Silt on north bank of Las Baños Creek [18], *Corbis peninsularis* Anderson and Hanna, *in* Anderson, 1958 (p. 61), from CAS loc. 2359, Upper Asuncion, Garzas Member, south side of Deer Valley [15], and *Corbis peninsularis* Anderson and Hanna, *in* Anderson, 1958 (p. 61), from CAS loc. 25707, Upper Asuncion, Garzas Member, SW¼ Sec. 27, T1N, R2E [15], are all *Calva* (*C.*) *varians* (Gabb).

Aphrodina major (Packard) of Anderson and Hanna (1935, p. 28) from CAS loc. 1431, near Santa Catarina Landing is *C.* (*C.*) *peninsularis.*

Calva (*Calva*) *varians* (Gabb, 1864)

Figures 67–89

Venus varians Gabb, 1864, p. 161 (in part), pl. 23, fig. 140–140a, only. Not fig. 141 = *Calva buttensis* Anderson, 1958.

Aphrodina varians (Gabb) Stewart, 1930, p. 249, pl. 6, fig. 6.

"*Trigonocallista*" *varians* (Gabb) Anderson, 1958, p. 138. Not *Trigonocallista* cf. *T. varians* (Gabb) Hall, 1958, p. 54, pl. 7, fig. 2 = *Calva* (*Egelicalva*) *spissa,* new species. Not *Calva varians* (Gabb)

←

Figures 50–57. *Calva* (*Calva*) *peninsularis* (Anderson and Hanna). All ×1; all specimens whitened with ammonium chloride. **50, 51,** UCMP cat. no. 36119, holotype, from UCMP loc. A-467, **50,** exterior, **51,** hinge. **52,** LACMIP cat. no. 8219, hypotype, from UCLA loc. 2415, hinge. **53, 55,** LACMIP cat. no. 8220, hypotype, from UCLA loc. 2415, **53,** hinge, **55,** exterior. **54, 56, 57,** UCMP 38658, hypotype, from UCMP loc. A-467, **54,** exterior left valve, **56,** exterior right valve, **57,** anterior view. Photos 50, 51, 54, 56, 57 by Susuki; 52, 53 by Saul; 55 by De Leon.

Table 5. Measurements of *Calva* (*Calva*) *peninsularis.* Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 8219			17.8		10.4	3.3	105°	—	—	—	—	3.2
LACMIP 8220	39.6	46.4	16.5	20.4	10.7	3.0	93°	1.2	2.8	2.3	1.9	3.6
LACMIP 8221	65.8	75.0	29.0	29.0	15.5	4.5	103°	1.1	2.6	2.6	1.9	3.4
LACMIP 8222	61.5	67.4	24.7	25.7	14.5	3.7	100°	1.1	2.7	2.6	1.8	3.9
LACMIP 8223	58.2	66.8	24.0	24.0	12.3	3.5	113°	1.1	2.8	2.8	2.0	3.5

Dailey and Popenoe, 1966, p. 16, pl. 4, figs. 1–4; Saul, 1970, p. 80, fig. 16 = C. (*Egelicalva*) *crassa,* new species. Not *Calva varians* (Gabb) Saul, 1986, p. 26, figs. 7–9 = *Loxo quintense* Saul, in press.

DIAGNOSIS. A *Calva* with nearly straight lunular margin, smooth lateral teeth, and cardinal tooth 1 longer than and approaching closer to the beak than 3a.

DESCRIPTION. Shell of moderate size, nearly as high as long, inflated, thick; beaks prominent, moderately high, anterior to the mid-length of the shell, strongly prosogyrous; lunular margin straight to slightly convex; anterior end broadly rounded; ventral border slightly arched, medially flattened; posterior end bluntly truncate vertically; posterior dorsal border long, slightly arched; lunule moderately large, shallow, delimited by an inscribed line; escutcheon obscurely delimited.

Ligament groove arched behind low nymphae. Hinge of right valve with anterior tooth 3a shortest and median cardinal tooth 1 short, narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; 1 extending from near the hinge plate edge closer to the beak than 3a; posterior cardinal 3b long, straight, shallowly bifid, subparallel to the nymph; socket for lateral AII long, narrow, moderately deep, smooth, parallel to the lunular border of the shell; socket for PII deep, bounded below by a rather large projecting tooth. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; cardinal 2b thicker than 2a, trigonal, directed obliquely backward; posterior cardinal 4b continuous with the ventral side of the nymph, slightly longer than the anterior teeth, not very massive; anterior lateral AII long, wedge-shaped, parallel to the hinge border below the lunule, smooth sided; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broad, bluntly angulate, extending across one-half of valve length; dorsal arm nearly horizontal and straight; ventral arm steeply ascending, a little concave. Anterior adductor muscle scar deeply impressed, ovoid; posterior adductor muscle scar impressed, rather round.

LECTOTYPE. ANSP cat. no. 4383, designated by Stewart, 1930.

PARALECTOTYPES. ANSP cat. no. 76481 (eight specimens) and UCMP cat. nos. 39832–39833 from Martinez [15], Contra Costa Co., California.

HYPOTYPES. UCMP cat. no. 38656 from UCMP loc. 2609, near Martinez [15], Contra Costa Co., California. LACMIP cat. nos. 8226–8229 from UCLA loc. 3313, south side Deer Valley [15]; 8230 from UCLA loc. 3957, south side Deer Valley [15], Contra Costa Co.; 8231–8232 from UCLA loc. 6345, south of Ortigalita Creek [18], Merced Co.; 8233 from LACMIP loc. 29217, Cantinas Creek [21], San Luis Obispo Co., California.

TYPE LOCALITY. Martinez, Contra Costa Co., California.

GEOLOGIC AGE. Late Maastrichtian.

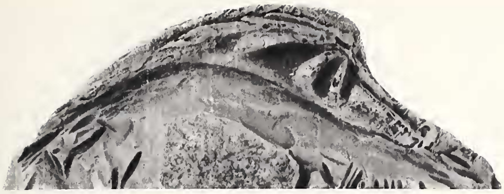
DISTRIBUTION. Great Valley Series near Martinez [15] and Deer Valley Formation of Colburn (1964) Deer Valley [15], Contra Costa Co.; Garzas Member of the Moreno Formation, east border of the Diablo Range, Stanislaus [17] and Merced Counties [18]; El Piojo Formation, near Lake Nacimiento [21], San Luis Obispo Co., California.

DIMENSIONS. See Table 6.

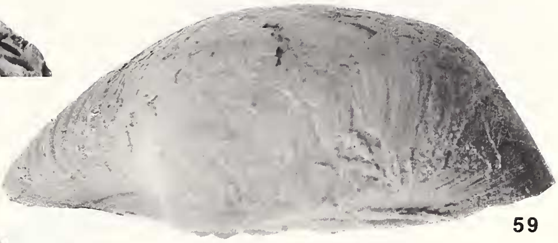
REMARKS. Gabb's name is apt for this species of variable elongation. The lectotype is more elongate and has a lower beak than most specimens of *Calva* (*C.*) *varians* from the type locality. It resembles specimens of *Loxo quintense* Saul (in press), but like other specimens of *C.* (*C.*) *varians* has a longer anterior lateral that parallels the lunular margin, and the shell is more roundly inflated than that of *L. quintense.*

⟶

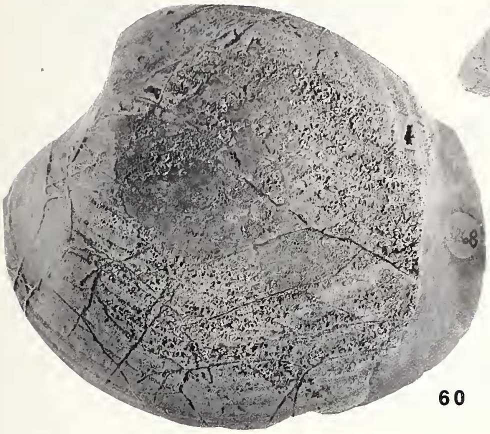
Figures 58–66. *Calva* (*Calva*) *peninsularis* (Anderson and Hanna). All ×1; all specimens whitened with ammonium chloride. 58, 60, LACMIP cat. no. 8223, hypotype, from UCLA loc. 3268, 58, hinge, 60, exterior. 59, 61–63, 66, LACMIP cat. no. 8221, hypotype, from LACMIP loc. 2855, 59, dorsal view, 61, anterior view, 62, posterior view, 63, exterior, 66, hinge. 64, LACMIP cat. no. 8222, hypotype, from LACMIP loc. 5989, interior. 65, LACMIP cat. no. 8224, hypotype, from UCLA loc. 3268, pallial sinus. Photos 58, 59, 64, 66 by Saul; 60–63, 65 by De Leon.



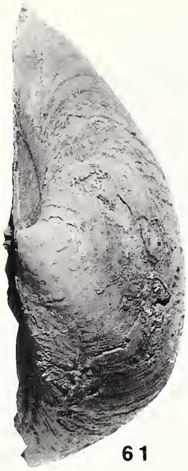
58



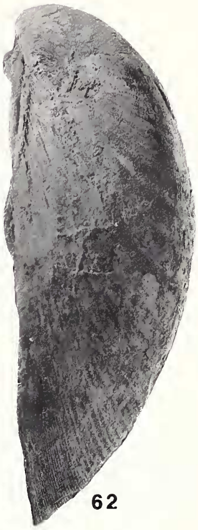
59



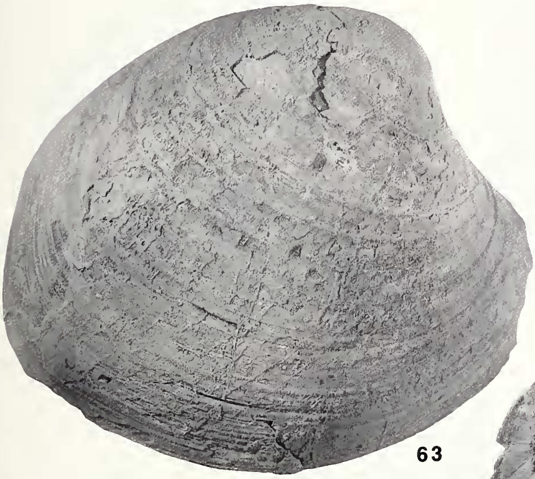
60



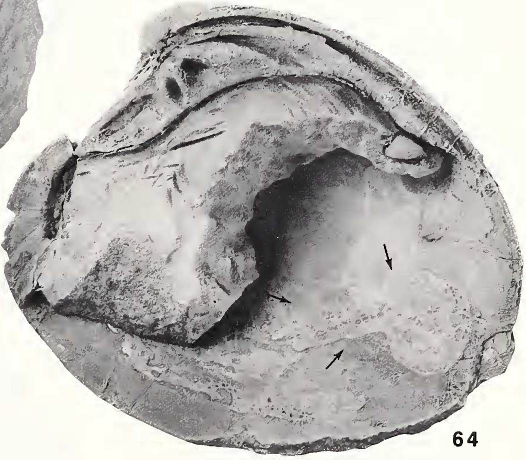
61



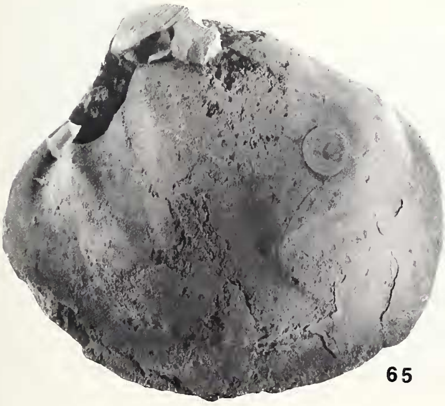
62



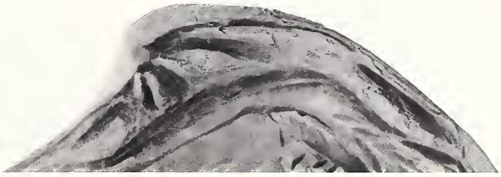
63



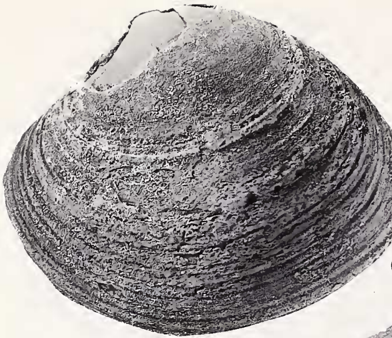
64



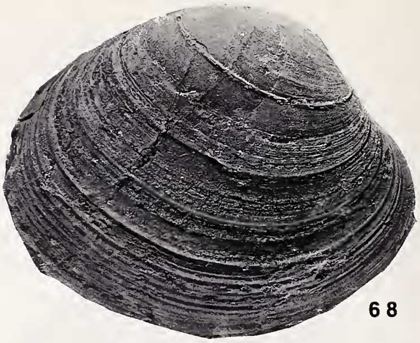
65



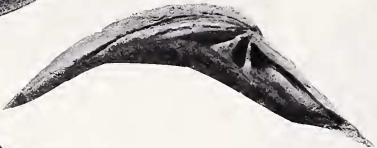
66



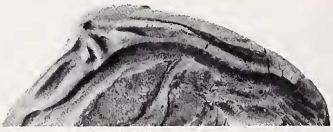
67



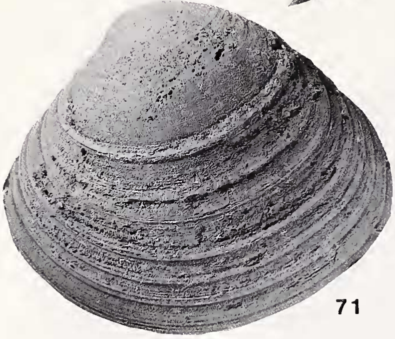
68



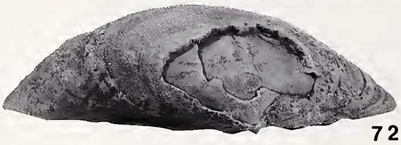
69



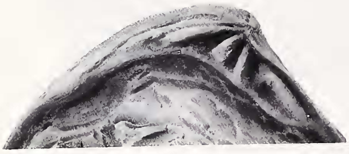
70



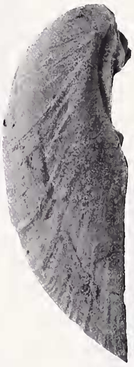
71



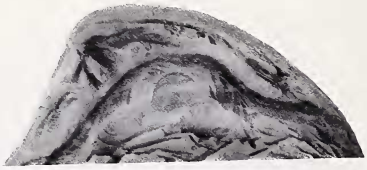
72



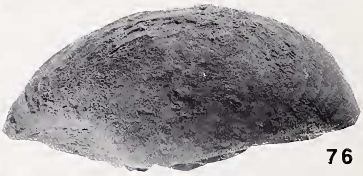
73



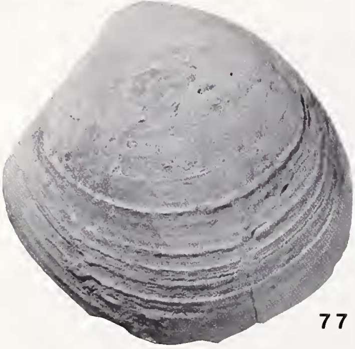
74



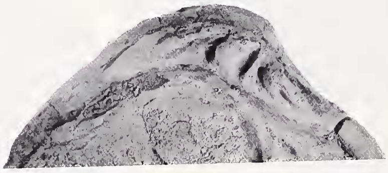
75



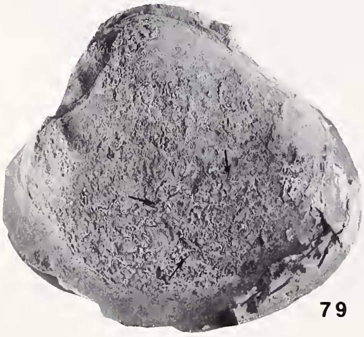
76



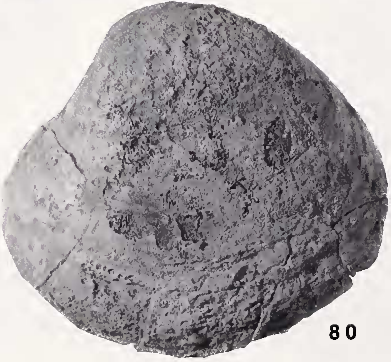
77



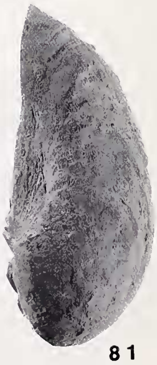
78



79



80



81

Table 6. Measurements of *Calva* (*Calva*) *varians.* Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
UCLA 36284*	40.7	49.0	16.0	22.0	13.7	3.7	105°	1.2	3.1	2.2	1.6	3.7
UCLA 36285*	43.0	48.7	15.5	23.6	12.3	3.7		1.1	3.1	2.1	1.9	3.3
UCLA 36286*	41.5	49.7	16.5	20.7	13.0	3.5		1.2	3.0	2.4	1.6	3.7
LACMIP 8225	45.4	50.8	19.0	20.0	13.7	4.4	113°	1.1	2.7	2.5	1.4	3.1
LACMIP 8226	37.0		16.0	18.0	11.5	3.0	110°	—	—	—	1.6	3.8
LACMIP 8227	54.3	61.0	25.8	21.8	15.5	5.5	97°	1.1	2.4	2.8	1.4	2.8
LACMIP 8228	44.4	48.0	18.0	22.4	16.5	3.9	91°	1.1	2.7	2.1	1.4	4.2
LACMIP 8229	48.6	50.4	21.8	21.7	15.4	5.7	90°	1.0	2.3	2.3	1.4	2.7
LACMIP 8231	41.6	48.0	18.9	21.0	15.0	4.0	99°	1.2	2.5	2.3	1.4	3.8
LACMIP 8232	48.0	53.0	18.9	22.4	11.4	3.0	98°	1.1	2.8	2.4	2.0	3.8

* Plaster casts of ANSP 4383, 76481a, 76481b.

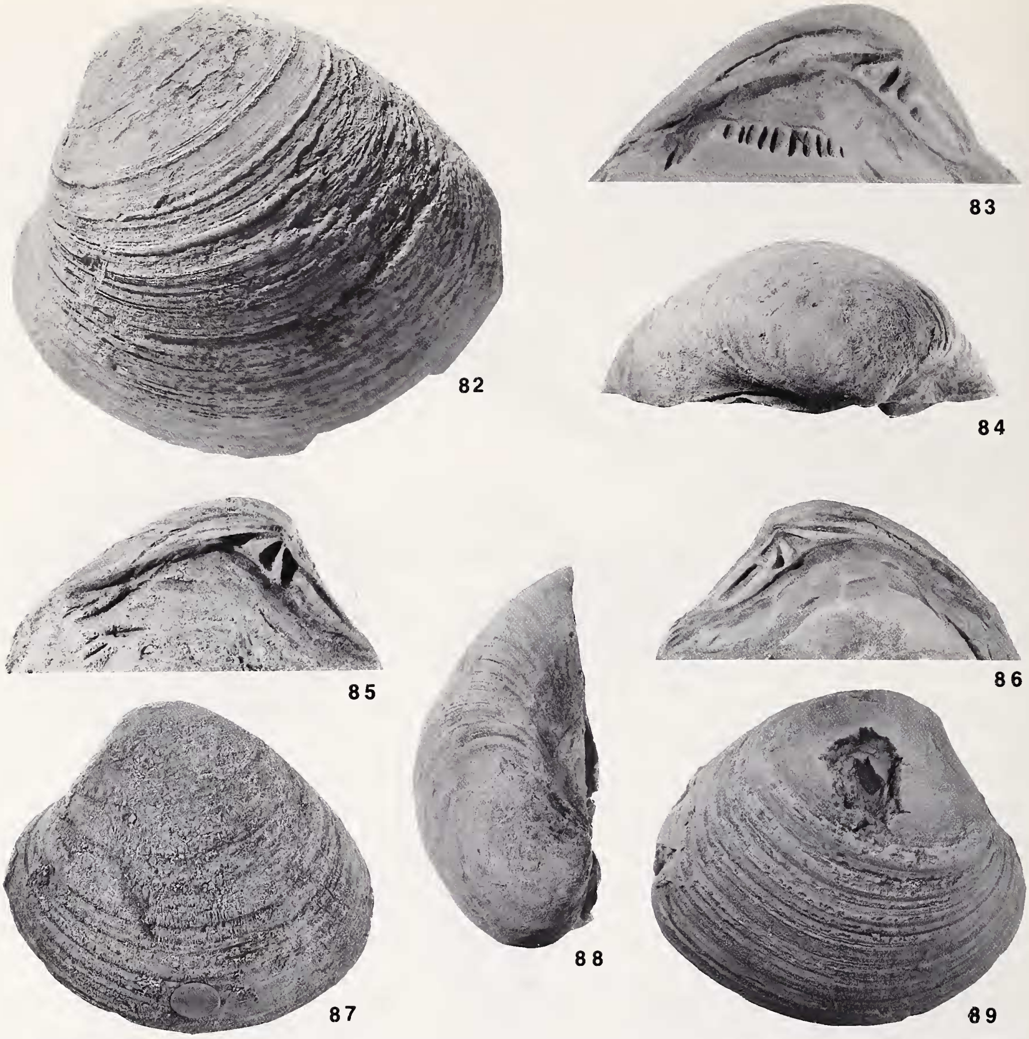
Gabb (1864, p. 231) listed *Venus varians* from 12 localities now known to range in age from Cenomanian to late Maastrichtian. Among these localities only the type locality, Martinez, provides specimens conspecific with the lectotype. Although all of the specimens Gabb identified as *Venus varians* could have been considered to be syntypes, Stewart (1927, 1930) did not use this term, nor, after he had selected the lectotype, did he refer to remaining specimens identified by Gabb as paralectotypes. Gabb's specimens of *Venus varians* from his 12 localities belong to several of the species described in this paper, and only his specimens from the type locality are treated as paralectotypes of *Calva* (*Calva*) *varians* (Gabb, 1864). Two of the specimens, UCMP cat. nos. 39832–39833, in a box labeled (in a hand resembling Gabb's) "*Venus varians* G. Siskiyou Mts." are C. (C.) *varians* and have the preservation and matrix of specimens from Martinez. A fragment of a *Meekia sella* Gabb, 1864, a species common at Martinez but not found in the Siskiyou Mountains is in the matrix of UCMP cat. no. 39832, and UCMP cat. nos. 39832–39833 are considered to be paralectotypes of C. (C.) *varians.* Merriam (1895) listed *Venus* (*Chione*) *varians* Gabb; vol. I, pl. 23, fig. 140, among the type specimens in the Geological Museum of the University of California, but Stewart (1930) did not record its catalogue number and said that it should be in the Museum of Paleontology. A specimen, marked "type," labeled as from the Siskiyou Mountains, was considered by Stewart to be possibly the specimen referred to by Merriam, but despite several searches, this specimen is not now recognizable.

None of the specimens of *Calva* (C.) *varians* is as large as large specimens of C. (*Egelicalva*) *crassa. Calva* (C.) *varians* is more elongate than C. (*E.*) *crassa,* and whereas the lunular border in C. (*E.*) *crassa* is concave, in C. (C.) *varians* it is nearly straight or slightly convex, and the lunule is relatively narrow, more elongate oval than heart-shaped or lanceolate. The stratigraphic ranges of C. (*E.*) *crassa* and C. (C.) *varians* overlap as both are present in the Moreno Formation at UCLA loc. 6345, south of Ortigalita Creek [18], Merced Co., California. Although other occurrences of C. (*E.*) *crassa* are from deposits of early Maastrichtian age, this overlap is considered to be of mid Maastrichtian age because C. (C.) *varians* occurrences are of mid and late Maastrichtian age. Three other specimens in the box are *Calva* (*E.*) *spissa* and undoubtedly from the lower Hornbrook Formation of the Siskiyou Mountains.

In shape *Calva* (C.) *varians* varies from somewhat elongate subquadrate resembling C. (C.) *campanae* to shorter subquadrate. It differs from C. (C.) *campanae* in being more inflated and having a slightly higher beak. *Calva* (C.) *varians* is less inflated than C. (C.) *peninsularis* and does not have the distinctive strong posterior angulation of that

←

Figures 67–81. *Calva* (*Calva*) *varians* (Gabb). All ×1; all specimens whitened with ammonium chloride. **67, 69, 72,** ANSP cat. no. 4383, lectotype, from Martinez, **67,** exterior, **69,** hinge, **72,** dorsal view. **68,** ANSP cat. no. 76481a, paralectotype, from Martinez, exterior. **70,** LACMIP cat. no. 8226, hypotype, from UCLA loc. 3313, hinge. **71,** ANSP cat. no. 76481b, paralectotype, from Martinez, exterior. **73, 74, 77,** LACMIP cat. no. 8228, hypotype, from UCLA loc. 3313, **73,** hinge, **74,** posterior view, **77,** exterior. **75, 76, 81,** LACMIP cat. no. 8229, hypotype, from UCLA loc. 3313, **75,** hinge, **76,** dorsal view, **81,** anterior view. **78, 80,** LACMIP cat. no. 8232, hypotype, from LACMIP loc. 29217, **78,** hinge, **80,** exterior. **79,** LACMIP cat. no. 8230, hypotype, from UCLA loc. 3957, pallial sinus. Photos 67–69, 71, 72 by Susuki; 70, 73–75 by Saul; 76–81 by De Leon.



Figures 82–89. *Calva* (*Calva*) *varians* (Gabb). All ×1; all specimens whitened with ammonium chloride. **82–84, 88,** LACMIP cat. no. 8227, hypotype, from UCLA loc. 3313, **82,** exterior, **83,** hinge, **84,** dorsal view, **88,** anterior view. **85, 87,** LACMIP cat. no. 8231, hypotype, from UCLA loc. 6345, **85,** hinge, **87,** exterior. **86, 89,** UCMP cat. no. 38656, hypotype, from UCMP loc. 2609, **86,** hinge, **89,** exterior. Photos 82 by Susuki; 83–89 by De Leon.

species. *Calva* (*C.*) *baptisia* has a shorter more swollen anterior lateral AII. *Calva* (*C.*) *varians* differs from *Loxo quintense,* new species, with which it occurs north of Lake Nacimiento [21] and at Garzas Creek [17], in being relatively less elongate, having more prominent beaks, and having anterior lateral tooth AII and its socket parallel to the lunular margin and more distant from the cardinal teeth.

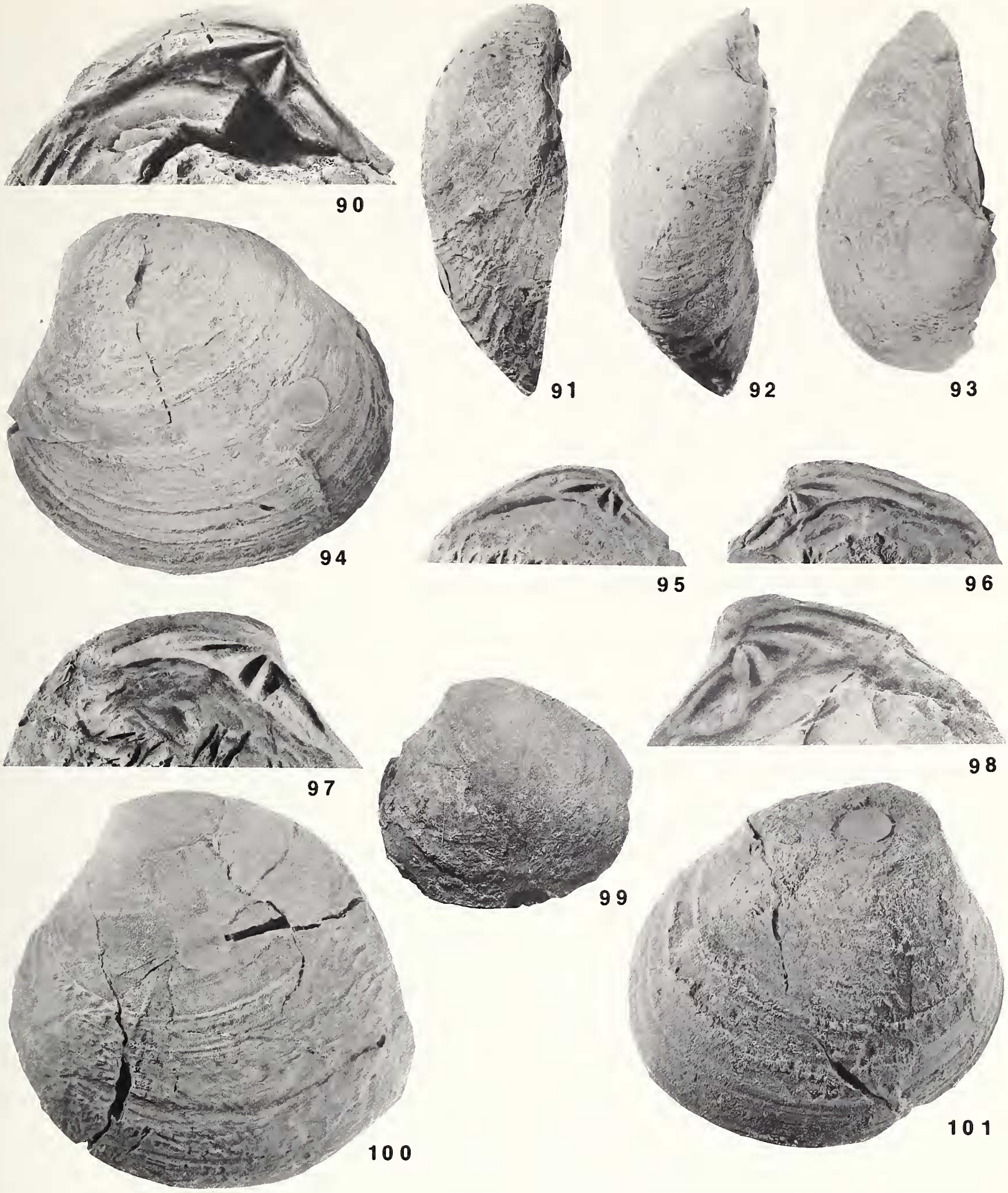
Venus varians, Trigonocallista varians, or *Calva varians* appear on faunal lists from many Pacific Slope Cretaceous localities of various geologic ages, but only those specimens from rocks of mid to late Maastrichtian age are likely to be *Calva* (*C.*) *varians.* Hall's (1958) specimen of supposed latest Jurassic or earliest Cretaceous age is discussed under *C.* (*Egelicalva*) *spissa.* Dickerson's (1914) *Venus varians* from UCMP loc. 783, one-half mile west of Lower Lake, Lake Co., California, is closer to *Lucina alcatrazis* Anderson, 1938, than to *C.* (*C.*) *varians* and may be of Cenomanian rather than Maastrichtian age.

Calva (*Calva*) *baptisia,* new species

Figures 90–101

Calva cf. *C. varians* (Gabb) Saul, 1986, p. 29, figs. 41–43.

DIAGNOSIS. A relatively short, rounded *Calva* with anteriorly placed beak, straight lunular margin, smooth lateral teeth, and cardinal 3a noticeably shorter than 1; 1 extending from near the hinge



Figures 90–101. *Calva* (*Calva*) *baptisia,* new species. All ×1; all specimens whitened with ammonium chloride. All from UCLA loc. 6526. **90–94,** LACMIP cat. no. 7559, holotype, **90,** hinge, **91,** posterior view, **92,** dorsal view, **93,** anterior view, **94,** exterior. **95, 99,** LACMIP cat. no. 8235, paratype, **95,** hinge, **99,** exterior. **96,** LACMIP cat. no. 8234, paratype, hinge. **97, 100,** LACMIP cat. no. 8183, paratype, **97,** hinge, **100,** exterior. **98, 101,** LACMIP cat. no. 7560, paratype, **98,** hinge, **101,** exterior. Photos 90, 98 by Saul; 91–97, 99–101 by De Leon.

plate edge and approaching the beak more closely than 3a; lateral AII enlarged, swollen, shortened.

DESCRIPTION. Shell of moderate size, nearly as high as long, inflated, thick; beaks prominent, moderately high, placed anterior to the mid-length of the shell, prosogyrous; lunular margin slightly convex to straight; anterior end rounded; ventral border arched; posterior end rounded; posterior dorsal border long, slightly arched; lunule moderately large, impressed, delimited by an inscribed line; escutcheon delimited by blunt angulation.

Ligament groove long, arched, nymph strong, smooth. Hinge of right valve with anterior cardinal tooth 3a and median cardinal tooth 1 sturdy, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks, 1 noticeably longer than 3a and more closely approaching beak; posterior cardinal 3b long, arched, shallowly bifid, subparallel to the nymph; socket for lateral AII

Table 7. Measurements of *Calva* (*Calva*) *baptisia*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 7559	49.5	54.5	19.7	23.3	12.0	3.4	103°	1.1	2.8	2.3	1.9	3.5
LACMIP 7560	49.4	50.2	20.0	18.3	13.0	5.0	101°	1.0	2.5	2.7	1.4	2.6
LACMIP 8183	53.2	55.3?	17.3	24.0	15.7	4.4		1.0	3.2	2.3	1.5	3.6
LACMIP 8234					7.7	2.2	124°	—	—	—	—	3.5
LACMIP 8235	31.5	34.3	10.8	13.5?	7.7	2.4	123°	1.1	3.2	2.5	1.8	3.2

moderately long, deep, smooth, parallel to the lunular border of the shell; socket for PII deep, bounded below by a rather large projecting tooth. Hinge of left valve with anterior cardinal 2a prominent, slender, somewhat posteriorly directed; cardinal 2b slightly thicker than 2a, directed posteriorly; posterior cardinal 4b nearly twice as long as 2a and 2b, sturdy; anterior lateral AII moderately long, parallel to the hinge border below the lunule, smooth sided, thick, a little hooked at the dorsal end; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus and muscle scars unknown.

HOLOTYPE. LACMIP cat. no. 7559.

PARATYPES. LACMIP cat. nos. 7560, 8234–8235 from UCLA loc. 6526, Dip Creek [21], San Luis Obispo Co., California.

TYPE LOCALITY. UCLA loc. 6526, Dip Creek [21], Lime Mountain Quadrangle, San Luis Obispo Co., California.

GEOLOGIC AGE. Latest Maastrichtian and ?earliest Danian.

DISTRIBUTION. Dip Creek Formation of Taliaferro (1944) on Dip Creek [21], San Luis Obispo Co.; basal San Francisquito Formation on Warm Springs Mountain, Los Angeles Co. [23], California.

DIMENSIONS. See Table 7.

REMARKS. *Calva* (*C.*) *baptisia* differs from *C.* (*C.*) *varians* in being more equant and in having a shorter anterior end, a wider LTA, a shorter lunule, a straighter lunular margin, and a shorter anterior lateral. The posterior margin of the right valve LACMIP 7560 is smashed (Fig. 98), obscuring the posterior lateral and socket, but the posterior portion of the right hinge is preserved in LACMIP 8234 (Fig. 96). "*Dosiniopsis*" *stewartvillensis* Clark and Woodford, 1927, from the Meganos Formation of Contra Costa Co. [15], California, resembles *C.* (*C.*) *baptisia*. "*Dosiniopsis*" *stewartvillensis* is rounder than *C.* (*C.*) *baptisia*, has a shorter anterior lateral, and lacks posterior laterals, although the posterior shell margin is grooved. As in *C.* (*C.*) *baptisia*, the anterior laterals of "*D.*" *stewartvillensis* are not striated, and it is not a *Dosiniopsis*. Its right posterior cardinal 3b differs from that of *Calva* in being widely bifid and curved anteriorly as in *Nitidavenus* Vokes, 1939, and "*D.*" *stewartvillensis*, despite its superficial resemblance to *C.* (*C.*) *baptisia*, is an unlikely descendent. The cardinal teeth of *Calva* suggest that descendents might more likely be found in *Callista* Poli, 1791.

ETYMOLOGY. The specific name is from Greek, *baptisis*, a dipping, dyeing, for the type locality on Dip Creek [21], San Luis Obispo Co., California.

Subgenus *Egelicalva*, new subgenus

TYPE SPECIES. *Cucullaea bowersiana* Cooper, 1894.

DIAGNOSIS. *Calva* spp. of trigonal shape, smooth except for growth lines and checks, having the lunule impressed and wide and the escutcheon very obscurely developed. Hinge plate moderately to strongly arched, with the major flexure at or in front of cardinal tooth 3b, the posterior lateral socket relatively long and narrow, and posterior lateral PI well developed but low. Pallial sinus linguiform.

DISCUSSION. *Egelicalva*, the *Calva nitida* lineage, comprises *C.* (*E.*) *byblidis*, *C.* (*E.*) *nitida*, *C.* (*E.*) *spissa*, *C.* (*E.*) *taffi*, *C.* (*E.*) *buttensis*, *C.* (*E.*) *bowersiana*, and *C.* (*E.*) *crassa*. Species of *Egelicalva* of Albian through early Campanian age have laterals that are more coarsely striated than those of the typical lineage. Their vertical striations are localized on longitudal welts, and the sockets are wider below the welts. The ventral side of the posterior lateral socket, both sides of the anterior lateral socket, and the dorsal side of the anterior lateral tooth have these finely striate welts. Species of the *C. nitida* lineage are of medium to large size and have a moderately to well arched hinge plate that is relatively narrow and a lunule that is wide and deeply impressed. Posterior lateral PI of the right valve barely extends beyond the plane of the commissure and bounds a socket that is relatively narrower than that of *Calva* s.s. The pallial sinus of *Egelicalva* is narrower at the pallial line and of more linguiform shape than that of *Calva* s.s.

Egelicalva bears a greater resemblance to *Trigonocallista* Rennie, 1930, than does *Calva* s.s. *Egelicalva* has striations on the laterals of Turonian and earlier species that are similar in size to the striations on the laterals of *Trigonocallista*. Both *Egelicalva* and *Trigonocallista* have a more trigonal shape, whereas *Calva* s.s. is more truncate posteriorly and has a more quadrate shape. *Egelicalva* differs from *Trigonocallista* in having the escutcheon obscurely indicated rather than clearly demarked, a deeper pallial sinus, anterior lateral AII straight but with a sharp posterior interiorward bend rather than being slightly arched concavely to the exterior, and the anterior arm of the bifid cardinal 3b shorter than the posterior arm rather than equal to or longer than the posterior arm.

ETYMOLOGY. The subgeneric name is compounded from Latin *egelidus,* lukewarm, tepid, chilly, refering to the apparently cooler, more northern distribution of this group, and *Calva* and is of feminine gender.

Calva (*Egelicalva*) *byblidis,* new species

Figures 102–113

DIAGNOSIS. An *Egelicalva* with striated lateral teeth. Cardinal tooth 1 extending to the hinge plate margin and somewhat distant from the beak; cardinal 3a shorter than 1 and extending closer to the beak than 1.

DESCRIPTION. Shell of moderate size, slightly longer than high, roundly inflated posteriorly, moderately thick; beaks prominent, high, anterior to the mid-length of the shell, prosogyrous; lunular margin slightly concave; anterior end produced, rounded, ventral border broadly arched; posterior end barely truncate; posterior dorsal slope long, slightly arched; lunule lanceolate, sunken, circumscribed by a fine line and a ridge; escutcheon faintly marked off, extending the length of the posterior dorsal border; shell surface polished, marked by growth lines and distant, lightly impressed growth checks.

Ligament groove long, behind smooth, posteriorly salient nymphs. Hinge of right valve with anterior cardinal 3a short, narrow, overhanging the socket for 2a; medial cardinal 1 narrowly triangular, based at the ventral hinge plate margin and not extending as far beakward as 3a and 3b; posterior cardinal 3b long, barely arched, shallowly bifid; socket for lateral AII long, moderately deep, parallel to the lunular border of the shell; socket for PII long, deep, bounded below by a long, projecting tooth. Hinge of left valve with anterior cardinal 2a prominent, narrowly trigonal, aligned almost vertically beneath the beak; cardinal 2b thicker than 2a, trigonal, directed obliquely backward; posterior cardinal 4b longer than the anterior teeth, slender, high, slightly arcuate, set off from nymph by marked groove; anterior lateral AII long, parallel to the lunular margin, wedge-shaped, posteriorly hooked; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broadly linguiform, ascending, extending to mid valve length; dorsal arm slightly convex, nearly horizontal; ventral arm barely concave, ascending at angle of about 35° to pallial line. Anterior adductor muscle scar impressed.

HOLOTYPE. LACMIP cat. no. 8098.

PARATYPES. LACMIP cat. nos. 8099 and 8104 from LACMIP loc. 29231, Texas Springs [9]; 8100 and 8101 from LACMIP loc. 29230, Texas Springs [9]; 8102 from UCLA loc. 3916, Texas Springs [9]; USNM cat. no. 456068 from USGS loc. 1051, Texas Springs [9], Shasta Co., California.

HYPOTYPE. LACMIP cat. no. 8146 from UCLA 4285, from a slump block, south of Sites [13], Colusa Co., California.

TYPE LOCALITY. LACMIP loc. 29231, Texas Springs [9], Shasta Co., California.

GEOLOGIC AGE. Early Albian, *Brewericeras hulenense* Zone.

DISTRIBUTION. Budden Canyon Formation at Texas Springs [9], Shasta Co.; ?Great Valley Series south of Sites [13], Colusa Co., California.

DIMENSIONS. See Table 8.

REMARKS. *Calva* (*Egelicalva*) *byblidis* resembles *Calva* s.s. species in having the escutchon obscurely demarked, but it is less truncate posteriorly, and its anterior lateral is more strongly striate. It is most similar to *C.* (*E.*) *nitida* from which it differs in being slightly more elongate, having a deeper lunule, and having cardinal tooth 1 more distant from 3a and more ventrally placed on the hinge plate.

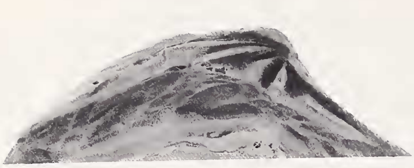
The species is fairly common in deposits of early Albian age near Texas Springs [9], Shasta Co., but because the shells are recrystallized and the matrix is hard, specimens are difficult to extract. Only the seven most complete specimens have been used in this study; all are from the vicinity of Texas Springs, Shasta Co., California. An additional incomplete specimen from a transported block 2.8 miles south of Sites is referred to this species with reservations. Whiteaves (1876) described *Callista* (?) *subtrigona* from the Queen Charlotte Islands, British Columbia, but the whereabouts of his figured specimen is not known. The Royal British Columbia Museum has a number of specimens identified by Whiteaves from localities with *Anagaudryceras sacya* (Forbes, 1846) suggesting that *Callista* (?) *subtrigona* Whiteaves is of late Albian to early Cenomanian age. Whiteaves' (1876, p. 63, pl. 9, fig. 10) original figure is of a much more rounded form than that of any available specimen of *Calva* (*Egelicalva*) *byblidis.* Only LACMIP cat. no. 8099, a specimen considered to be deformed, has an outline approaching that of Whiteaves' figure. Additionally, Whiteaves illustrated and several of the Royal British Columbia Museum specimens show a very trigonal pallial sinus rather than the linguiform shape of *C.* (*E.*) *byblidis*; the two species are doubtless distinct.

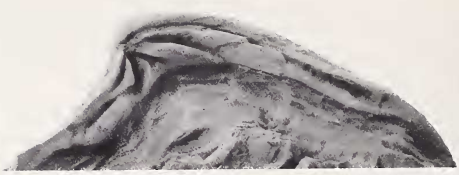
ETYMOLOGY. The specific name is derived from Greek, *Byblis,* a nymph changed into a spring.

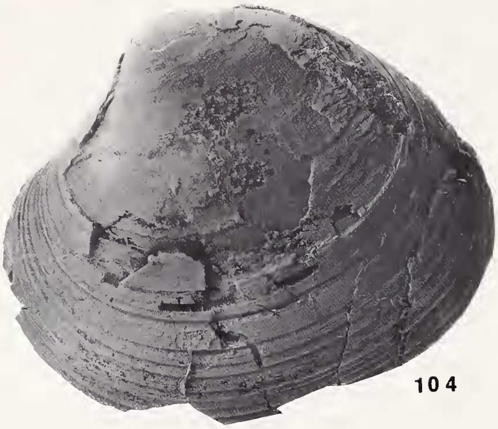
Calva (*Egelicalva*) *nitida*
(Gabb, 1864)

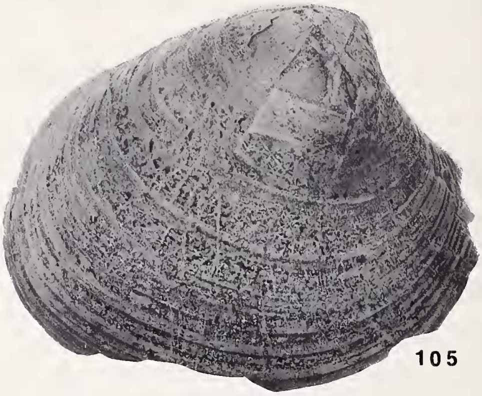
Figures 114–135

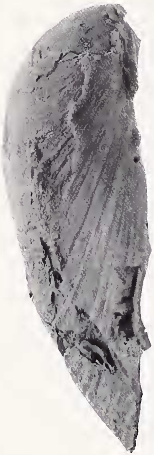
Meretrix nitida Gabb, 1864, p. 165, pl. 23, figs. 145–146. Not *Meretrix nitida* Gabb Whiteaves, 1903, p. 377, includes *Calva* (*Egelicalva*) *buttensis* (Anderson, 1958) and *C.* (*E.*) *bowersiana* (Cooper, 1894).

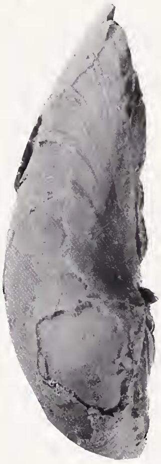

102

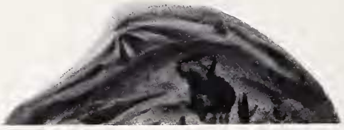

103

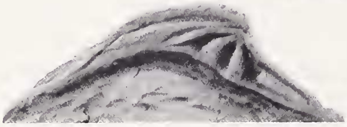

104

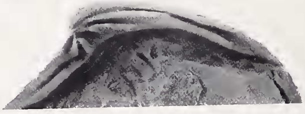

105

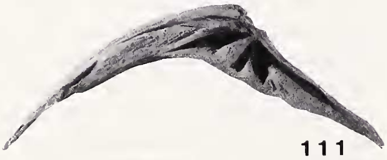

108

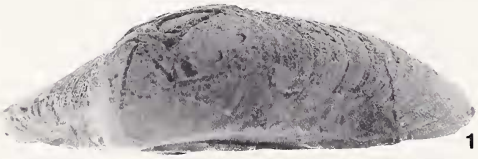

109

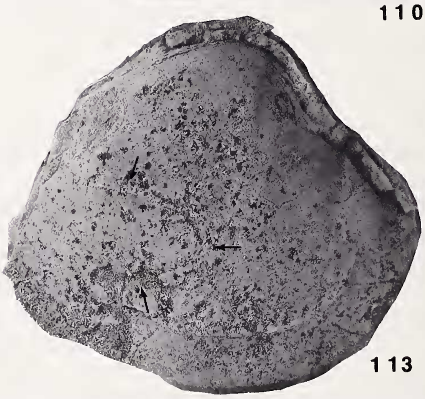

106


107


110


111


112


113

Figures 102–113. *Calva* (*Egelicalva*) *byblidis*, new species. All ×1; all specimens whitened with ammonium chloride. **102, 104, 108, 109,** LACMIP cat. no. 8100, paratype, from LACMIP loc. 29230, **102,** hinge, **104,** exterior, **108,** posterior view, **109,** anterior view. **103, 105, 111,** LACMIP cat. no. 8098, holotype, from LACMIP loc. 29231, **103,** hinge, **105,** exterior, **111,** dorsal view. **106,** LACMIP cat. no. 8099, paratype, from LACMIP loc. 29231, hinge. **107,** USNM cat. no. 456068, paratype, from USGS loc. 1051, hinge. **110,** LACMIP cat. no. 8101, paratype, from LACMIP loc. 29230, hinge. **112,** LACMIP cat. no. 8104, hypotype, from LACMIP loc. 29231, pallial sinus. **113,** LACMIP cat. no. 8146, hypotype, from UCLA loc. 4285, hinge. Photos 102–112 by Saul; 113 by De Leon.

Table 8. **Measurements of *Calva* (*Egelicalva*) *byblidis*. Dimensional abbreviations defined in Figure 4.**

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 8098	49.0	61.8	17.0	27.3	19.4	4.7	118°	1.3	3.6	2.3	1.4	4.1
LACMIP 8099	42.6	46.0	17.0	25.0	14.2	4.3	114°	1.1	2.7	1.8	1.8	3.3
LACMIP 8100	52.6	63.8	16.7	27.0	15.0	4.4	124°	1.2	3.8	2.4	1.8	3.4
LACMIP 8101			13.0		13.0	4.0	116°	—	—	—	—	3.2
LACMIP 8102			17.0		16.4	4.6	121°	—	—	—	—	3.6
LACMIP 8146			18.0		17.5	4.4	108°	—	—	—	—	4.0
USNM 456068	43.8		18.7	24.8	19.0	4.4	124°	—	—	—	1.3	4.3

Caryatis nitida (Gabb) Gabb, 1869, p. 186, pl. 30, fig. 79.

Aphrodina nitida (Gabb) Stewart, 1930, p. 250, pl. 5, fig. 10; pl. 6, fig. 9.

"*Trigonocallista*" *nitida* (Gabb) Anderson, 1958, p. 139. Not *Trigonocallista nitida* (Gabb) Taff, Hanna, and Cross, 1940, p. 1232, pl. 2, figs. 3–4 = *Calva* (*Egelicalva*) *taffi* Anderson, 1958.

DIAGNOSIS. A trigonal, slightly longer than high *Egelicalva* with striated lateral teeth, the lunular border nearly straight. Cardinal tooth 1 extending to the hinge plate margin. Cardinal 3a shorter than 1 and extending closer to the beak than 1.

DESCRIPTION. Shell of moderate size, slightly longer than high, inflated, moderately thick; beaks prominent, high, anterior to the mid-length of the shell, prosogyrous; lunular border nearly straight; anterior end slightly produced, sharply rounded, ventral border broadly arched; posterior end barely truncate; posterior dorsal border long, slightly arched; posterior dorsal slope arched; lunule heart-shaped, sunken, circumscribed by a fine line; escutcheon faintly marked off by obscure angulation, extending the length of the posterior dorsal border; shell surface polished, marked by growth lines and distant barely impressed growth checks.

Ligament groove arched behind smooth, posteriorly salient nymphs. Hinge of right valve with anterior cardinal 3a short, narrow, prominent; medial cardinal 1 narrowly triangular, based at the ventral hinge plate margin; posterior cardinal 3b long, straight, shallowly bifid subparallel to the nymph; socket for lateral AII long, narrow, moderately deep, parallel to the lunular border of the shell, finely striate along both sides; socket for PII deep, bounded below by large projecting tooth PI; PI finely striate along dorsal face. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; left median cardinal 2b thicker than 2a, trigonal, directed obliquely backward; left posterior cardinal 4b continuous with the ventral side of the nymph, slightly longer than the anterior teeth, not very massive; anterior lateral AII long, prominent and hooked posteriorly, parallel to the lunular valve margin, finely striate along dorsal face; striae at posterior end of tooth noticeably coarsest; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus linguiform with angulate tip, slightly ascending, extending to valve mid-length; dorsal arm convex, nearly horizontal; ventral arm concavely ascending. Anterior adductor muscle scar impressed, at the anterior end of the hinge plate, posterior adductor muscle scar lightly impressed.

LECTOTYPE. ANSP 4374. Gabb did not designate type specimens or type localities. Stewart (1927, 1930) commonly referred to Gabb's illustrated specimens as holotypes and gave preference in designating lectotypes to figured specimens or to specimens from the same lot or locality as Gabb's figured specimen. Stewart (1930) did not find the specimens of *Meretrix nitida* that Gabb had figured and chose not to designate a lectotype for this species but figured two specimens from the same lot as Gabb's figured specimens. The larger of these, ANSP 4374, is here designated as lectotype.

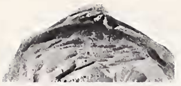
PARALECTOTYPE. ANSP 4374a from the type locality.

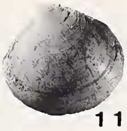
HYPOTYPES. LACMIP cat. nos. 8106–8107 from LACMIP loc. 6165, Andy Bernard Ranch [5], Crook Co., 8111–8113 from UCLA loc. 4669, near Suplee, Crook Co. [5], Oregon; 8105 from LACMIP loc. 28766, Stony Creek, Glenn Co. [12], 8108–8109 from LACMIP 10871, Elder Creek [10], Tehama Co., California. CAS cat. no. 28104.01 from CAS loc. 28104, Curry Canyon [15], Contra Costa Co., California.

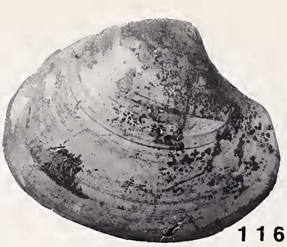
TYPE LOCALITY. "Near Martinez [15], in loose blocks on the shores of the Straits of Carquines" (Gabb, 1864).

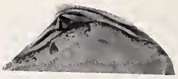
GEOLOGIC AGE. Late Albian–Cenomanian; associated with *Turrilites* at Suplee [5], Crook Co., Oregon; from *Turrilites dilleri* Zone in Ono area [9], Shasta Co., California (Rodda, 1959, p. 96).

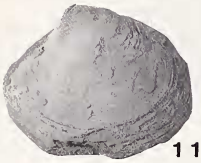
DISTRIBUTION. Hudspeth Formation, along Rock Creek [4], Wheeler Co., and near Dayville [4], Grant Co., Oregon; Bernard Formation, Suplee [5], Crook Co., Oregon; Osburger Gulch Sandstone Member of the Hornbrook Formation near Jacksonville [6], Jackson Co., Oregon; Bald Hills Member of the Budden Canyon Formation, near Ono [9], Shasta Co., California. Redeposited (?) clasts, of possible or probable late Albian age, in Cenomanian strata, at Curry Canyon [15], Contra Costa

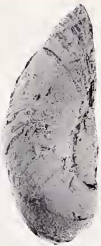

114

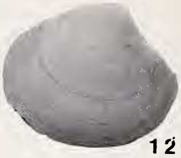

115

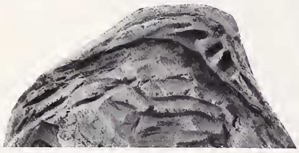

116

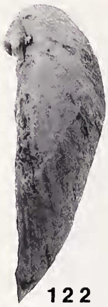

117

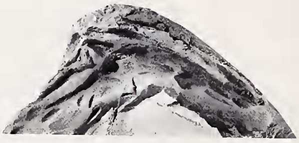

118

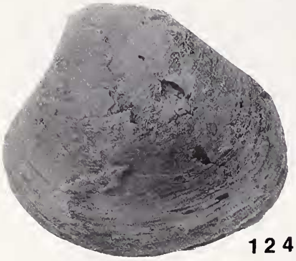

119

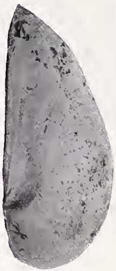

120

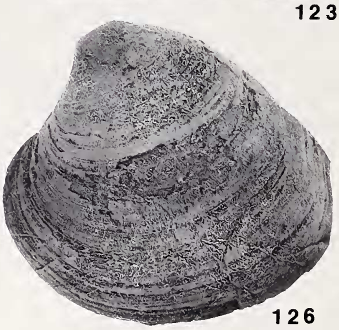

121

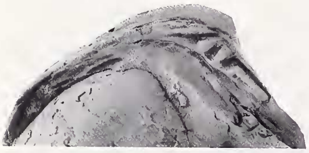

122

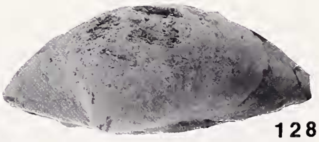

123

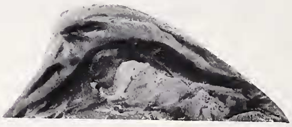

124

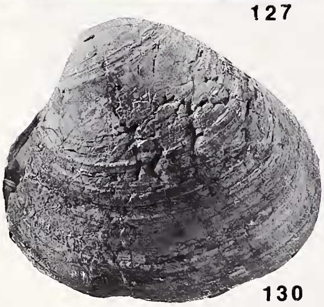

125

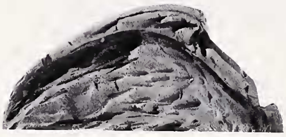

126

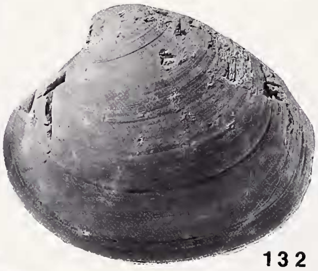

127

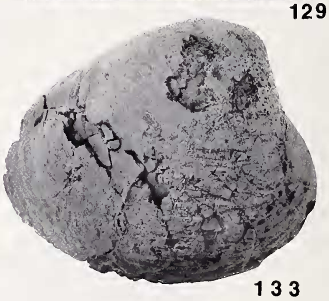

128

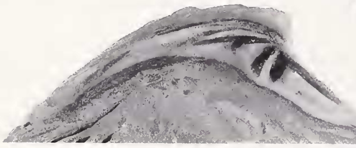

129

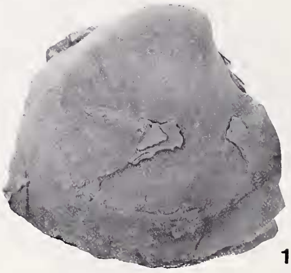

130


131


132


133


134


135

Figures 114–135. *Calva* (*Egelicalva*) *nitida* (Gabb). All ×1; except as indicated, all specimens whitened with ammonium chloride. **114, 118,** CAS cat. no. 28104.01, hypotype, from CAS loc. 28104, **114,** hinge, **118,** exterior. **115,** ANSP cat. no. 4374, paralectotype, from Martinez, exterior, without whitening. **116,** ANSP cat. no. 4374a, lectotype, from Martinez, exterior, without whitening. **117, 120,** LACMIP cat. no. 8108, hypotype, from LACMIP loc. 10871, **117,** hinge, **120,** exterior. **119, 121, 124,** LACMIP cat. no. 8106, hypotype, from LACMIP loc. 6165, **119,** anterior view, **121,** hinge, **124,** exterior. **122, 123, 126,** LACMIP cat. no. 8107, hypotype, from LACMIP loc. 6165, **122,** posterior view, **123,** hinge, **126,** exterior. **125, 128, 129, 133,** LACMIP cat. no. 8112, hypotype, from UCLA loc. 4669, **125,** anterior view,

Table 9. Measurements of *Calva* (*Egelicalva*) *nitida*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/LW
UCLA 28770*	14.7	15.7	6.6					1.1	2.4	—	—	—
UCLA 28771*	29.5	35.5	11.4					1.2	3.1	—	—	—
LACMIP 8105	53.0?	62.0	22.7	28.0?	15.0	5.6	108°	1.2	2.7	2.2	1.9	2.7
LACMIP 8106	33.7	37.8	12.8	17.8	10.8	4.0	107°	1.1	2.9	2.1	1.6	2.7
LACMIP 8107	37.7	41.8	14.8	20.1	12.0	4.5	106°	1.1	2.8	2.1	1.7	2.7
LACMIP 8108	19.5	23.7	7.3	11.0	6.0	2.3	107°	1.2	3.2	2.1	1.8	2.6
LACMIP 8109	32.8	36.4	7.0	17.0	10.0	3.7	111°	1.1	5.2	2.1	1.7	2.7
LACMIP 8110	19.4	24.0	8.4	10.7	7.0	2.7	127°	1.2	2.9	2.2	1.5	2.6
LACMIP 8111	35.0	40.4	16.0	16.5	12.0?	3.5	101°	1.2	2.5	2.4	1.4	3.4
LACMIP 8112	34.5	40.5	12.8	18.7	11.2	4.1	102°	1.2	3.2	2.2	1.7	2.7

* Plaster casts of ANSP 4374 and 4374a.

Co., Sites, Antelope Creek, and Peterson Ranch [13], Colusa Co., Elder Creek [10], Tehama Co., North Fork of Cottonwood Creek [9], Shasta Co., etc., along the western border of the northern Great Valley (Rodda, 1959; Brown and Rich, 1960).

DIMENSIONS. See Table 9.

REMARKS. *Calva* (*Egelicalva*) *nitida* and *Calva* (*Calva*) *varians* have commonly been confused and reported to co-occur. Gabb (1864, p. 165) remarked upon the great resemblance between *Meretrix nitida* and *Venus varians* but used the smaller size, polished surface, fewer and less distinct lines of growth, and the presence of a deeply impressed line bordering the lunule of *M. nitida* to distinguish it from *V. varians*. However, those characters, which depend in part upon conditions of preservation or of growth, cannot define species (Stewart, 1930), and both species have an inscribed line bordering the lunule. *Calva* (*E.*) *nitida* has a more prominent beak, is more strongly concave just anterior to the beak, and has a straighter, more steeply sloping posterior dorsal margin than *C.* (*C.*) *varians*. The anterior laterals of *C.* (*E.*) *nitida* are striated but those of *C.* (*C.*) *varians* are smooth. *Calva* (*E.*) *nitida* is more trigonal than *C.* (*C.*) *regina*, *C.* (*C.*) *peninsularis*, *C.* (*C.*) *baptisia*, *C.* (*E.*) *byblidis*, *C.* (*E.*) *bowersiana*, and *C.* (*Penecallista*) *marina*. Its anterior end is relatively longer than that of *C.* (*C.*) *regina*, *C.* (*C.*) *peninsularis*, *C.* (*C.*) *varians*, or *C.* (*C.*) *baptisia*. It never develops the hunched over aspect of the posterodorsal area exhibited by *C.* (*E.*) *taffi*, usually by *C.* (*E.*) *crassa*, and sometimes by *C.* (*C.*) *varians*. It resembles *C.* (*E.*) *bowersiana*, but striations on its lateral teeth are visible without magnification, whereas those on the laterals of *C.* (*E.*) *bowersiana* are present only on small specimens and require a magnification of at least 30×. The anterior lateral socket in the right valve does not connect with the socket for 2a. Cardinal tooth 1 of *C.* (*E.*) *nitida* has a more triangular shape and is in a more ventral position closer to the hinge plate margin than that of any geologically younger *Calva*.

For both *Meretrix nitida* and *Venus varians* the type locality is in the vicinity of Martinez [15], but they do not occur in the same beds there or elsewhere. Gabb's specimens from the "loose blocks on shore of Carquines Strait" have a distinctly different matrix from that of the type material of *V. varians*. The matrix additionally contains some other fossils not found in association with *V. varians* but that are found in collections from Curry Canyon [15], on the slope of Mt. Diablo, Contra Costa Co. The matrix, furthermore, resembles that from Curry Canyon [15], and specimens of *M. nitida* identical in appearance to Stewart's (1930) figured specimens (Figs. 115, 116) are found at Curry Canyon [15] (Figs. 114, 118).

The age of the Curry Canyon [15] occurrences of *Calva* (*Egelicalva*) *nitida* is possibly late Albian or more probably Cenomanian. *Calva* (*E.*) *nitida* has been found in the Bald Hills Member of the Budden Canyon Formation, near Ono [9], Shasta Co., which contains Cenomanian ammonites (Rodda, 1959; Murphy and Rodda, 1960), and in Oregon with Cenomanian ammonites.

Calva (*Egelicalva*) *nitida* occurs from central Oregon [4] to Contra Costa Co. [15], California. Although Whiteaves (1903) identified it from the Nanaimo Basin Deposits in British Columbia, those of his specimens that have been examined are *Calva* (*E.*) *bowersiana* or, as is the case of some specimens

---

←
128, dorsal view, **129**, hinge, **133**, exterior. **127**, **130**, LACMIP cat. no. 8111, hypotype, from UCLA loc. 4669, **127**, hinge, **130**, exterior. **131**, **132**, LACMIP cat. no. 8109, hypotype, from LACMIP loc. 10871, **131**, hinge, **132**, exterior. **134**, LACMIP cat. no. 8105, hypotype, from LACMIP loc. 28766, hinge. **135**, LACMIP cat. no. 8113, hypotype, from UCLA loc. 4669, pallial sinus. Photos 114, 118–120, 123, 129, 131, 134 by De Leon; 115, 116, 130, 132 by Susuki; 117, 121, 122, 124–128, 133, 135 by Saul.

at the Royal British Columbia Museum that were labeled as *Caryatis nitida* by Whiteaves, are *C.* (*Microcalva*) *haggarti,* new species. If, as seems likely, some of his specimens came from lower horizons than the specimens presently available, they might well be *C.* (*E.*) *buttensis* (Anderson, 1958).

Calva (*Egelicalva*) *spissa,* new species

Figures 136–154

Trigonocallista cf. *T. varians* (Gabb, 1864) Hall, 1958, p. 54, pl. 7, fig. 2.

DIAGNOSIS. A trigonal *Egelicalva* with nearly straight lunular margin and finely striate lateral teeth. Cardinal tooth 1 extending barely to hinge plate edge; 3a short.

DESCRIPTION. Shell thick, of moderate size, nearly as high as long, rather trigonal; beaks prominent, moderately high, anterior to the mid-length of the shell, prosogyrous; lunular margin nearly straight; anterior end bluntly rounded; ventral border broadly arched; posterior end obscurely truncated, arched into the posterior dorsal border; lunule heart-shaped, moderately large, delimited by an inscribed line; escutcheon not delimited; shell surface polished, marked by growth lines and distant, well-impressed growth checks.

Ligament groove long, arched, behind moderate nymphs. Hinge plate broad. Hinge of right valve with anterior tooth 3a short, vertically directed immediately beneath the beak; median cardinal 1 longer but narrower, close to 3a, directed a little posteriorly; 3b elongate, bifid; socket for AII long, deep, subparallel to the lunular valve margin, finely striate on both sides; socket for PII deep, narrow, bounded below by prominent projecting lateral PI; PI finely striate on dorsal side. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; left median cardinal 2b thicker than 2a, trigonal, directed posteriorly; posterior cardinal 4b longer than the anterior cardinals, slender; anterior lateral AII posteriorly hooked, parallel to the lunular valve margin, striate along dorsal face; striae noticeably coarsest at posterior end; posterior lateral tooth PII a salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus extending across two-fifths of valve length, ascending, broadly linguiform with subangulate tip; dorsal arm slightly convexly ascending; ventral arm concavely ascending at angle of about 50° to pallial line. Anterior adductor muscle scar ovoid; posterior adductor muscle scar bean-shaped.

HOLOTYPE. LACMIP cat. no. 8114.

PARATYPES. LACMIP cat. nos. 8115 from LACMIP loc. 10782, Stinking Creek [8], Shasta Co., 8116–8119 from UCLA loc. 5422, Rancheria Gulch [7], Siskiyou Co., 8120 from UCLA loc. 4251, Young Ranch [7], Siskiyou Co., 8121 from UCLA loc. 5522, SE ridge of Garza Peak [20], Kings Co., 8129–8139 from UCLA loc. 4250, Young Ranch [7], Siskiyou Co., 8131 from UCLA loc. 6370, Cooper Canyon [19], Fresno Co., California. CAS cat. nos. 31920.02–31920.03 from CAS loc. 31920, Thompson Creek [13], Yolo Co., 29491.01 from CAS loc. 29491, Salado Creek [17], Stanislaus Co., California. UCMP cat. no. 39829–39831 from Siskiyou Mts. [7], Oregon–California border. USNM cat. no. 456069 from USGS loc. 660 = USGS loc. 21369, 1 mile southeast of Buckeye [8], vicinity of Dry Creek, Shasta Co., California. LACMIP cat. nos. 8125–8126 from LACMIP loc. 10903, Ashland Creek [6], Jackson Co., Oregon.

TYPE LOCALITY. LACMIP loc. 10769, Dry Creek [8], Shasta Co., California.

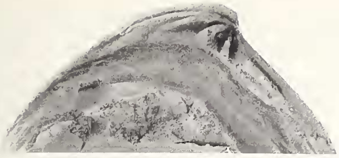
GEOLOGIC AGE. Turonian; associated with *Tragodesmoceras ashlandicum* (Anderson, 1902) and *Subprionocyclus* spp.

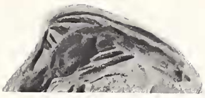
DISTRIBUTION. Hornbrook Formation, Osburger Gulch Member, Ashland region [6], Jackson Co., Oregon; Hornbrook Formation, Osburger Gulch Member, Rancheria Gulch [7], near Henley, Siskiyou Co.; Redding Formation, Bellavista Sandstone Member, Redding area [8], Shasta Co.; basal Yolo Shale, Thompson Creek [13], Yolo Co.; Great Valley Series in Arroyo del Valle, Alameda Co. [15]; lower Panoche Formation on Salado Creek [17], Stanislaus Co., California. Well-preserved specimens are from a clast in the Panoche Formation on an eastward trending spur of Garza Peak [20], Kings Co., California.

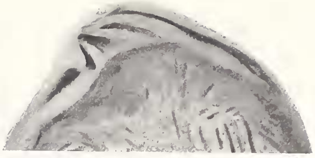
DIMENSIONS. See Table 10.

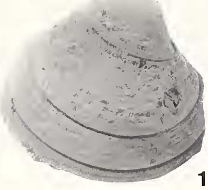
REMARKS. Three paratypes of *Calva* (*Egelicalva*) *spissa,* UCMP cat. nos. 39823–39830, are labeled in a hand resembling Gabb's "*Venus varians* G. Siskiyou Mts." and are probably the basis for Gabb's (1864, p. 231) listing *V. varians* from the Siskiyou Mountains. Also in the same box were paralectotypes of *Calva* (*C.*) *varians* discussed herein under that species. This agglomeration of specimens probably led Stewart (1930, p. 250) to say that University of California, Berkeley, had specimens from the Siskiyou Mountains conspecific with the lectotype of *C.* (*C.*) *varians. Calva* (*E.*) *spissa* is higher and more trigonal and has a longer lunule and longer lateral teeth than *C.* (*C.*) *varians,* and the lateral teeth of *C.* (*E.*) *spissa* are striate.

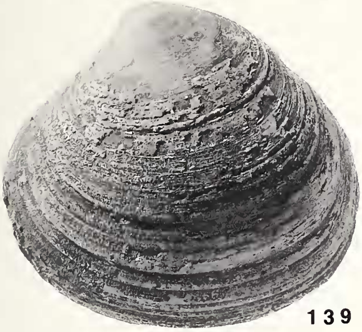
Calva (*Egelicalva*) *spissa* resembles *C.* (*E.*) *nitida* in being equantly trigonal but differs in having a steeper posterior slope, blunter anterior, broader umbonal area, less deeply impressed lunule, and broader pallial sinus. The anterior lateral of *C.* (*E.*) *spissa* is prominent and strongly hooked posteriorly, its socket is very deep and strongly hooked, and the striae at the posterior end of AII and on the dorsal face of AI are coarse enough to be seen under low magnification. Specimens of *C.* (*E.*) *spissa* have been identified as *C.* (*C.*) *regina,* but *C.* (*E.*) *spissa* is trigonal rather than subquadrate in shape and has more coarsely striated lateral teeth. *C.* (*E.*) *spissa* differs from *C.* (*E.*) *taffi* in lacking the hunched-over aspect to the beak and in having more coarsely striated laterals. Early Coniacian specimens are intermediate between *C.* (*E.*) *spissa* and *C.* (*E.*)

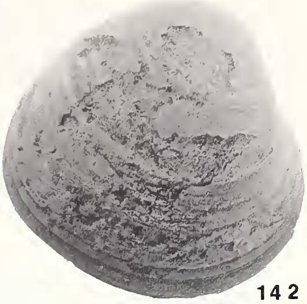

136

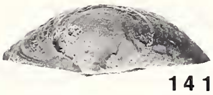

137

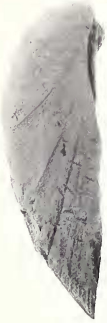

138

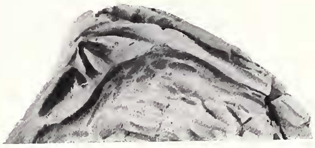

140

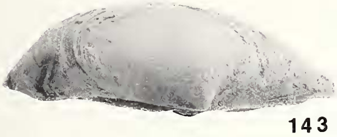

139

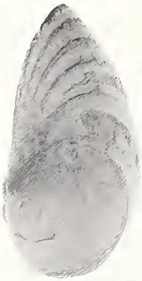

142

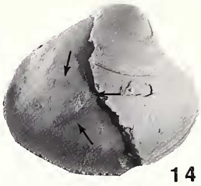

141

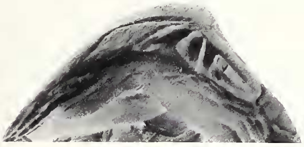

146

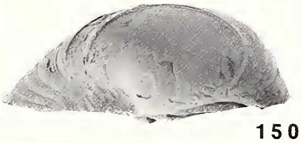

144

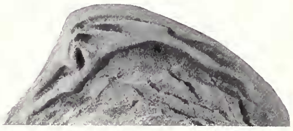

143

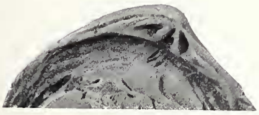

147

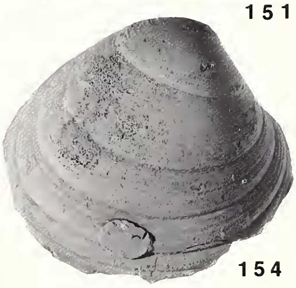

148

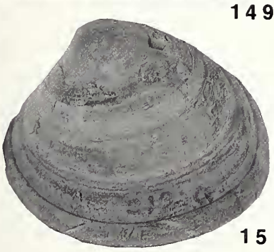

145

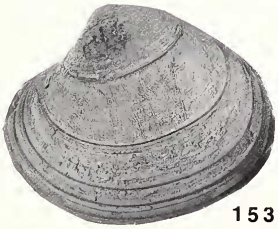

150


151


149


154


152


153

Figures 136–154. *Calva* (*Egelicalva*) *spissa*, new species. All ×1; all specimens whitened with ammonium chloride. **136, 139, 143,** LACMIP cat. no. 8114, holotype, from CIT loc. 1203, **136,** hinge, **139,** exterior, **143,** dorsal view. **137, 140, 141,** CAS cat. no. 29491.01, paratype, from CAS loc. 29491, **137,** hinge, **140,** exterior, **141,** dorsal view. **138, 142,** LACMIP cat. no. 8115, paratype, from LACMIP loc. 10782, **138,** hinge, **142,** exterior. **144,** LACMIP cat. no. 8116, paratype, from UCLA loc. 5422, hinge. **145, 146,** LACMIP cat. no. 8117, paratype, from UCLA loc. 5422, **145,** hinge, **146,** posterior view. **147, 150,** CAS cat. no. 31920.02, paratype, from CAS loc. 31920, **147,** anterior view, **150,** dorsal view. **148,** LACMIP cat. no. 8120, paratype, from UCLA loc. 4251, pallial sinus. **149, 152,** CAS cat. no. 31920.03, paratype, from CAS loc. 31920, **149,** hinge, **152,** exterior. **151, 154,** LACMIP cat. no. 8121, paratype, from UCLA loc. 5522, **151,** hinge, **154,** exterior. **153,** LACMIP cat. no. 8129, hypotype, from UCLA loc. 4250, exterior resembling C. (*E.*) *taffi*. Photos 136, 138, 140, 142, 143, 145–147, 150 by Saul; 137, 141, 144, 148, 149, 151–154 by De Leon; 139 by Susuki.

Table 10. Measurements of *Calva* (*Egelicalva*) *spissa*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 8114	40.5	44.0	13.8	23.0	13.7	2.8	99°	1.1	3.2	1.9	1.7	4.9
LACMIP 8115	40.0	41.7	14.5	23.0	13.0	4.3	94°	1.0	2.9	1.8	1.8	3.0
LACMIP 8116	40.5	44.7	14.3	21.0	13.8	4.5	96°	1.1	3.1	2.1	1.5	3.1
LACMIP 8117	37.6	41.7	14.0	21.8	12.8	3.0	92°	1.1	3.0	1.9	1.7	4.3
LACMIP 8121	35.6	38.5	14.4	19.5	10.8	4.3	104°	1.1	2.7	2.0	1.8	2.5
LACMIP 8122	30.3	35.9	11.3	14.2	9.3	1.9	110°	1.2	3.2	2.5	1.5	4.9
LACMIP 8129	29.5	35.7	11.1	14.4	8.1	2.9		1.2	3.2	2.5	1.8	2.8
CAS 29491.01	25.0	28.0	9.9	14.5	7.6	2.8	95°	1.1	2.8	1.9	1.9	2.7

taffi; they have the shape of *C.* (*E.*) *spissa* with the teeth of *C.* (*E.*) *taffi*.

The specimen figured by Hall (1958, pl. 7, fig. 2) (LSJU cat. no. 8458 = CAS cat. no. 66237.01) is a *Calva spissa*. This specimen, purported to be from the Oakland Conglomerate of ?Late Jurassic–Early Cretaceous age, is labeled as being collected in 1906, ½ mile [0.8045 km] northeast of Niles, in conglomerate along road up south side of Niles Canyon, Niles Quadrangle, Alameda Co., California. Crandall (1907) also reported a specimen of *Venus varians* from 1¼ miles [2.01125 km] northeast of Niles, but says that it was from a hard flinty limestone concretion. On-going studies of the Oakland Conglomerate by D. L. Jones (letter, 1990) show that previous workers have confused two conglomerates; one, the actual Oakland Conglomerate, is younger than mid-Cenomanian age, and the other, associated with beds containing *Buchia*, is not younger than Valanginian.

The specimen figured by Hall is a fairly well-preserved but recrystallized shell in an immature sandstone matrix that contains other similarly preserved pieces of shell. A sandstone so replete with fossils should have produced a considerable faunal list, but Hall (1958, p. 47) records only *T. varians* and *Aucella lahuseni* Pavlow from this locality. This sandstone and preservation of the enclosed fossils resemble preservation and matrix at CAS loc. 33706, Arroyo del Valle, Alameda Co., where *Calva* (*Egelicalva*) *spissa* also occurs. Matsumoto (1960, pp. 71, 95) has considered ammonites from this locality to indicate an early Turonian age. The matrix of Hall's figured specimen is moderately hard sandstone. None of the pieces of shell in the matrix of "*T. varians*" is from an "*Aucella*" = *Buchia*. Other than this specimen, no *Calva* of older than Albian age has been recognized. No strata of Turonian age have been recognized in Niles Canyon [15], but eastward in Arroyo del Valle [15], Alameda Co., beds of Turonian age are present (Matsumoto, 1960, p. 71). This specimen is so clearly a *Calva* (*E.*) *spissa* and its matrix so dissimilar to that of the Lower Cretaceous of the Pleasanton area, that a strong suspicion arises of specimens being transposed sometime between the collecting of fossils from Niles Canyon by Robert Anderson in 1906 and the figuring of this specimen by Hall in 1958.

ETYMOLOGY. The specific name is from Latin, *spissus*, close, dense, thick, slow.

Calva (*Egelicalva*) *taffi*
(Anderson, 1958)

Figures 155–190

Trigonocallista nitida (Gabb) Taff, Hanna, and Cross, 1940, p. 1322, pl. 2, figs. 3–4. Not *Meretrix nitida* Gabb, 1864; *Caryatis nitida* (Gabb), Gabb, 1869; nor *Aphrodina nitida* (Gabb), Stewart, 1930; all = *Calva* (*Egelicalva*) *nitida* (Gabb, 1864).

Calva sp. aff. *C. regina* Popenoe, Casey, 1952, p. 173, text figs. 90–91.

"*Trigonocallista*" *taffi* Anderson, 1958, p. 139, pl. 59, fig. 2–2a.

DIAGNOSIS. A nearly equant *Egelicalva* with a large lunule, strongly arched posterodorsal margin, giving the umbos a hunched-over aspect, and slightly convex lunular margin. Lateral teeth with fine striations localized on elongate welts, cardinal tooth 1 reaching barely to hinge plate edge, lateral AI large and swollen.

DESCRIPTION. Shell of moderate size, nearly as high as long, inflated, especially near the beak, thick; beaks prominent but rather low, anterior to the mid-length of the shell, prosogyrous; lunular margin slightly convex; anterior end rounded; ventral border broadly arched; posterior end subtruncate vertically; posterior dorsal border well arched; lunule large, clearly demarked by an inscribed line; escutcheon bounded by blunt angulation; shell surface polished, marked by growth lines and impressed growth checks.

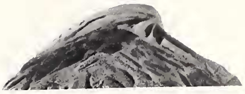
Ligament groove long, arched, behind moderate nymphs. Hinge of right valve with anterior tooth 3a and median cardinal tooth 1 short, narrow, prominent, close together, nearly equant in length, slightly divergent ventrally, situated directly beneath and having dorsal ends equally close to the beaks; right posterior cardinal 3b long, straight, shallowly bifid subparallel to the nymph; socket for lateral AII long, deep, parallel to the lunular border of the shell, finely striate along narrow, raised welts along both sides; socket for PII deep, bounded below by a rather large projecting tooth PI; PI finely striate along welt; welt lower on tooth at anterior, angling higher posteriorly. Hinge of left valve with anterior cardinal 2a prominent, very slender, aligned almost vertically beneath the beak; left median cardinal 2b thicker than 2a, trigonal, directed obliquely backward; left posterior cardinal 4b continuous with the ventral side of the nymph, slightly longer than the anterior teeth, not very massive; anterior lateral AII long, parallel to the hinge border below the lunule, finely striate on dorsal face; striae confined to raised longitudinal welt at mid tooth height; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broadly linguiform with subangulate tip, ascending, extending to near mid valve length; dorsal arm convexly gently ascending; ventral arm concavely ascending at angle of about 50° to pallial line. Adductor muscle scars moderately impressed, roundish.

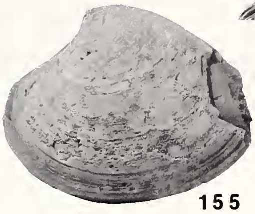
HOLOTYPE. CAS cat. no. 27836.01 [= CAS cat. no. 5789].

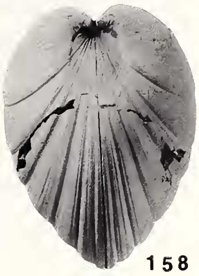
HYPOTYPES. LACMIP cat. nos. 8133 from LACMIP loc. 10847 [= CIT loc. 1016], Chico Creek [11], 8134 from UCLA loc. 3625, Chico Creek [11], 8135 from UCLA loc. 3623, Chico Creek [11], 8136–8138 from UCLA loc. 3627, Chico Creek [11], 8139 from LACMIP loc. 10849 [= CIT loc. 1017], Chico Creek [11], Butte Co., 8140, 8143 from UCLA loc. 4219, Oak Run, 8147 from UCLA loc. 4209, Clover Creek [8], 8149–8150 from LACMIP loc. 10824 [= CIT loc. 1232], Price Hollow [8], 8152–8153 from UCLA loc. 4106, Clover Creek [8], 8155–8157 from UCLA loc. 4217, Clover Creek [8], Shasta Co., California. CAS cat. nos. 27854.02 from CAS loc. 27854, Orestimba Creek [17], Stanislaus Co., California.

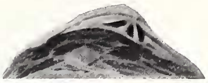
TYPE LOCALITY. Chico Creek [11], Butte Co., California. The holotype was reported to have come from CAS loc. 27836 (Taff et al., 1940, explanation of pl. 2, figs. 3–4; Anderson, 1958, p. 139), which is approximately 200–233 m (675 feet) above the base of the section. UCLA localities at this stratigraphic position yielded no specimens of *Calva* (*Egelicalva*) *taffi*. There is very little other material from CAS loc. 27836 at the California Academy of Sciences; one small tray, so numbered, of poorly preserved fossils in a matrix similar to that at UCLA loc. 3617 contains no *Calva*. The type specimen is beautifully preserved; the locality number 27835 was written upon it in black ink; the last digit was changed to a 6 in blue ink. *Calva* (*E.*) *taffi*, often in an excellent state of preservation, is common to abundant at several localities near the stratigraphic position of CAS loc. 27835, approximately 450–550 m (1600 feet) above the base of the section (Taff et al., 1940, p. 1316, fig. 1).

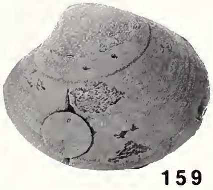
GEOLOGIC AGE. Coniacian–Santonian, associated with *Hyphantoceras oshimai* (Yabe, 1904), *H.* cf. *H. venustum* (Yabe, 1904) and *Baculites capensis* (Woods, 1906).

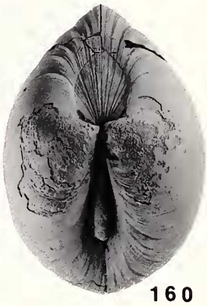

156

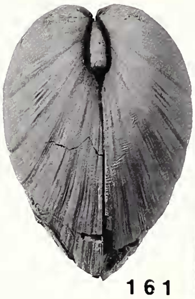

155

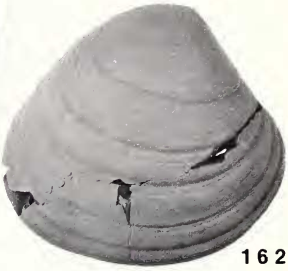

158


157


159


160


161


162

Figures 155–162. *Calva* (*Egelicalva*) *taffi* (Anderson). All ×1; all specimens whitened with ammonium chloride; all of Coniacian age. **155, 156,** CAS cat. no. 27854.02, hypotype, from CAS loc. 27854, **155,** exterior, **156,** hinge. **157, 159,** LACMIP cat. no. 8147, hypotype, from UCLA loc. 4209, **157,** hinge, **159,** exterior. **158, 160–162,** LACMIP cat. no. 8271, hypotype, from UCLA loc. 4245, **158,** anterior view, **160,** dorsal view, **161,** posterior view, **162,** exterior. Photos 155, 156 by De Leon; 157, 159, 162 by Saul; 158, 160 by Susuki.

DISTRIBUTION. Redding Formation (Members IV through VI? of Popenoe, 1943), east of Redding [8], Shasta Co.; Musty Buck Member of the Chico Formation on Chico Creek [11] and Butte Creek [11], Butte Co.; Lower Panoche Formation, Orestimba Creek [17], Stanislaus Co., California.

DIMENSIONS. See Table 11.

REMARKS. Anderson (1958) based this species on the figures of *Trigonocallista nitida* in Taff et al. (1940) but provided no description. His holotype is small and double valved, and the above hinge description is based upon probable topotype specimens. Specimens larger than the holotype and of Santonian age develop the most distinctive form of *Calva* (*Egelicalva*) *taffi*. They are relatively high and have a hunched-over aspect to the posterodorsal margin (Figs. 167, 170, 175, 178, 180, 181). *Calva* (*E.*) *taffi* specimens of Coniacian age (Figs. 155–162) are similar to *C.* (*E.*) *spissa* in shape and are relatively longer than are specimens from the vicinity of the type locality (Fig. 167). In outline these Coniacian specimens resemble *C.* (*E.*) *buttensis* or *C.* (*E.*) *bowersiana*. Specimens of late Santonian age are again predominantly more elongate (Figs. 182–190) and grade into *C.* (*E.*) *buttensis*. The three taxa *C.* (*E.*) *taffi*, *C.* (*E.*) *buttensis*, and *C.* (*E.*) *bowersiana* constitute an intergrading series in which mature specimens of the two end members are distinct, but small specimens cannot usually be allocated. Some relatively elongate specimens of *C.* (*E.*) *taffi* cannot be distinguished from *C.* (*E.*) *buttensis*, but the two forms are treated as separate species because the distinctive, relatively short *C.* (*E.*) *taffi* appears to be confined to the Santonian. Those with a less distinctive shape are separable from *C.* (*E.*) *buttensis* on the basis of the lunular margin, which is usually convex in *C.* (*E.*) *taffi* but straight to slightly concave in *C.* (*E.*) *buttensis*.

The specimen figured by Casey (1952) was provided by Popenoe. In Casey's (1952) figure 91, the escutcheon and lunule are indicated by dashed lines as though they were equally recognizable, but on specimens the lunule is depressed and delimited by an incised line and the escutcheon is indistinctly bounded by an obscure angulation (Fig. 177).

Calva (*Egelicalva*) *taffi* is relatively lower and longer than *C.* (*C.*) *heliaca* but relatively higher than other species of *Calva*; its lunule appears larger than that of *C.* (*E.*) *buttensis* and *C.* (*E.*) *bowersiana*. Like *C.* (*E.*) *nitida*, it has a trigonal shell. Its outline is similar to that of *C.* (*E.*) *crassa*, but it has striated laterals, and the largest specimens of *C.* (*E.*) *taffi* are a third as large as the largest *C.* (*E.*) *crassa*. *Calva* (*E.*) *taffi* resembles *C.* (*E.*) *spissa* in being thick shelled, trigonal, and heavy hinged, but *C.* (*E.*) *spissa* has a higher beak, lacks the hunched-over aspect to the posterodorsal margin, and has a proportionately longer and more prominent anterior lateral that is noticeably more coarsely striate at its dorsal end.

Specimens of *Calva* at CAS loc. 27854, Orestimba Creek [17], Stanislaus Co., ?base of the Panoche, occur with *Meekia louella* Popenoe, 1962. They are shaped more like *C.* (*Egelicalva*) *buttensis* but have a hinge like *C.* (*E.*) *taffi*. CAS loc. 27854 is the type locality of *Didymoceras orestimbense* Anderson, 1958, which Matsumoto (1959, p. 158; 1960, p. 84) considered to be *Hyphantoceras oshimae* (Yabe, 1904) and indicative of late Turonian or Coniacian age (Matsumoto, 1960, p. 84). These *Calva* and the *M. louella* suggest an early Coniacian age for this locality.

We have not seen Whiteaves' (1879, p. 149) specimen of *Cytherea* (*Caryatis*) *plana* (Sowerby) from the Productive Coal Measures, Division A (= Haslam or Pender Formation of Ward, 1978, late Santonian or early Campanian age) at the entrance to Departure Bay [2], Vancouver Island. The age and association with *Inoceramus schmidti* Michael, 1899, suggest that it and others identified from that vicinity as *Cytherea leonensis* Conrad by Etheridge (*in* Hector, 1861) may be *Calva* (*Egelicalva*) *taffi* or *C.* (*E.*) *buttensis*. Whiteaves (1903) later included all of these in *Meretrix nitida* Gabb. Although Etheridge referred to *Cytherea leonensis* Conrad, 1857, as the commonest fossil near Nanaimo, no worker since Whiteaves has mentioned *Calva*-like bivalves from that vicinity.

Specimens of *Calva* from the Chignik Formation west of Chignik Bay, Alaska Peninsula, Alaska (USGS loc. 6981), are similar to those of latest Santonian to earliest Campanian age in the Chico Formation. *Inoceramus schmidti* and *Canadoceras newberryanum* (Meek, 1857) are distributed throughout the Chignik Bay section of the Chignik Formation (Jones, 1963, p. 8). The *Calva* is referred to *C.* (*Egelicalva*) *buttensis* despite its large lunule, because the lunular margin is barely concave rather than convex as in typical *C.* (*E.*) *taffi*.

Calva (*Egelicalva*) *buttensis*
(Anderson, 1958)

Figures 191–210

Venus varians var.? Gabb, 1864, p. 161, in part, pl. 23, fig. 141 only (specimens from "Pence's Ranch," Butte Co.).

Trigonocallista varians (Gabb) Taff, Hanna, and Cross, 1940, p. 1321, pl. 2, figs. 10–11. Not *Venus varians* Gabb, 1864.

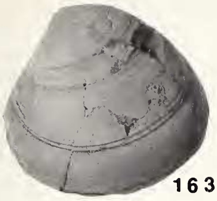
"Trigonocallista" buttensis Anderson, 1958, p. 140, pl. 59, fig. 1–1a.

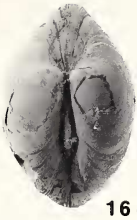
DIAGNOSIS. An *Egelicalva* with very fine striations on the lateral teeth localized on elongate welts. The lunular margin is nearly straight. Cardinal tooth 1 extending barely to hinge plate edge; 3a shorter than 1; lateral AI not swollen; hinge plate relatively narrow.

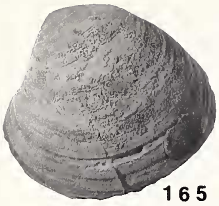
DESCRIPTION. Shell thick, of moderate size,

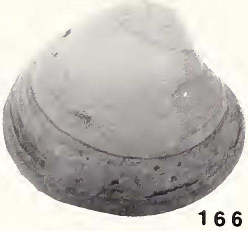
→

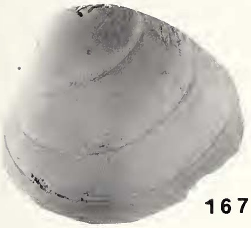
Figures 163–181. *Calva* (*Egelicalva*) *taffi* (Anderson). All ×1; all specimens whitened with ammonium chloride; all of early Santonian age. **163, 164,** CAS cat. no. 27836.01, holotype, from CAS loc. 27836, **163,** exterior left valve, **164,** dorsal view. **165, 171,** LACMIP cat. no. 8143, hypotype, from UCLA loc. 4219, **165,** exterior, **171,** hinge. **166, 169,**

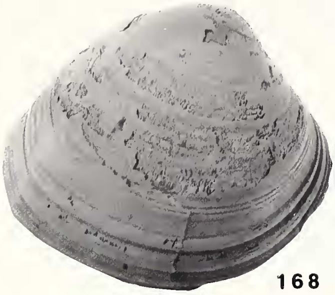

163

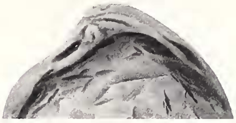

164

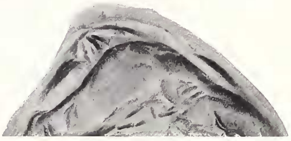

165

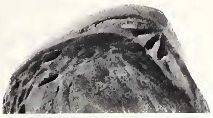

166

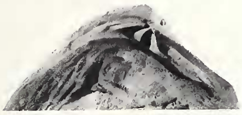

167

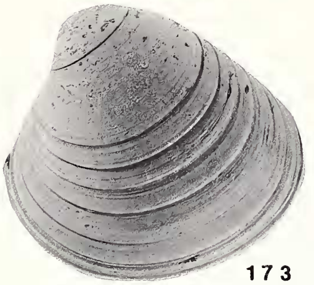

168

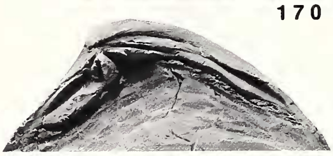

169

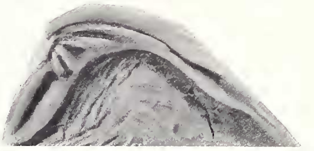

170

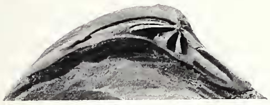

171

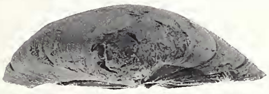

172

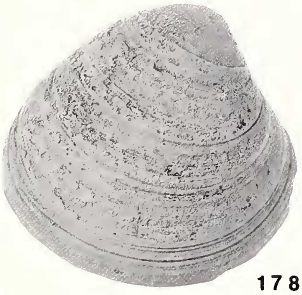

173

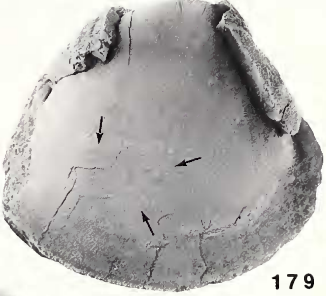

174

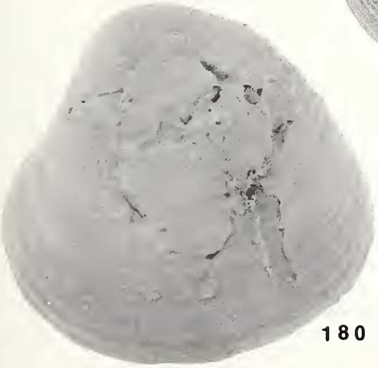

175

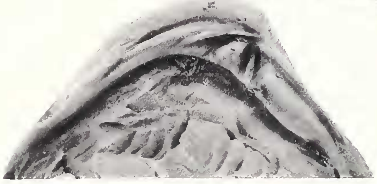

176


177


178


179


180


181

LACMIP cat. no. 8153, hypotype, from UCLA loc. 4106, **166**, exterior, **169**, hinge. **167**, LACMIP cat. no. 8133, hypotype, from LACMIP loc. 10847, exterior. **168, 174**, LACMIP cat. no. 8149, hypotype, from LACMIP loc. 10824, **168**, exterior, **174**, hinge. **169**, LACMIP cat. no. 8153, hypotype, from UCLA loc. 4106, hinge. **170, 178**, LACMIP cat. no. 8140, hypotype, from UCLA loc. 4219, **170**, hinge, **178**, exterior. **172**, LACMIP cat. no. 8152, hypotype, from UCLA loc. 4106, hinge. **173**, LACMIP cat. no. 8273, hypotype, from UCLA loc. 4106, exterior. **175**, LACMIP cat. no. 8134, hypotype, from UCLA loc. 3625, hinge. **176, 177**, LACMIP cat. no. 8150, hypotype, from LACMIP loc. 10824, **176**, hinge, **177**, dorsal view. **179**, LACMIP cat. no. 8139, hypotype, from LACMIP loc. 10849, pallial sinus. **180, 181**, LACMIP cat. no. 8135, hypotype, from UCLA loc. 3623, **180**, exterior, **181**, hinge. Photos 163, 165, 167, 169, 171, 172 by De Leon; 164, 166, 168, 170, 175, 178–181 by Saul; 173, 174, 176, 177 by Susuki.

Table 11. Measurements of *Calva* (*Egelicalva*) *taffi*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/LW
CAS 27836.01	25.2	27.5	9.7	12.0	9.0	2.6		1.1	2.8	2.3	1.3	3.5
CAS 27854.02	32.0	38.0	13.0	16.7	10.6	3.2	107°	1.2	2.9	2.3	1.6	3.3
LACMIP 8133	30.6	34.3	12.7	13.5	10.0	3.0		1.1	2.7	2.5	1.4	3.3
LACMIP 8135	46.4	48.7	20.7	25.4	15.4	4.8	84°	1.0	2.4	1.9	1.6	3.2
LACMIP 8136	36.0	41.0	15.8	17.0	12.0	3.8	99°	1.1	2.6	2.4	1.4	3.2
LACMIP 8137	34.0	37.6	11.5	16.8	13.7	4.3	90°	1.1	3.3	2.2	1.2	3.2
LACMIP 8138	15.4	18.1	6.2	8.7	5.4	1.4	107°	1.2	2.9	2.1	1.6	3.8
LACMIP 8140	37.0	39.0	15.4	20.5	12.3	3.6	86°	1.0	2.5	1.9	1.7	3.4
LACMIP 8143	26.6	28.0	12.5	13.0	8.1	2.8	97°	1.0	2.2	2.2	1.6	2.9
LACMIP 8147	21.6	26.9	9.3	11.4	7.0	1.9	113°	1.2	2.9	2.4	1.6	3.7
LACMIP 8149	37.0	42.0	14.6	17.5	11.0	3.3	100°	1.1	2.9	2.4	1.6	3.3
LACMIP 8150	29.7	35.4	12.3	17.4	10.0	3.0	107°	1.2	2.9	2.0	1.7	3.3
LACMIP 8152	32.0	35.0	11.0	14.5	10.0	3.7	95°	1.1	3.2	2.4	1.4	2.7
LACMIP 8153	28.0	31.8	12.5	14.9	8.9	2.8	99°	1.1	2.5	2.1	1.7	3.2
LACMIP 8155	24.6	27.4	11.0	13.8	8.5	3.2	95°	1.1	2.5	2.0	1.6	2.7
LACMIP 8156	21.6	25.7	9.8	12.4	7.0	3.0	102°	1.2	2.6	2.1	1.8	2.3

longer than high, inflated; beaks prominent, of moderate height, anterior to the mid-length of the shell, prosogyrous; lunular margin nearly straight; anterior end broadly rounded; ventral border broadly arched; posterior end abruptly rounded; posterior dorsal border moderately long, slightly arched; lunule elongate, depressed, moderately wide, well demarked by inscribed line; escutcheon delimited by angulation sharp near the beak, rounding to obscurity near the margin.

Ligament groove one-third length of dorsal border. Hinge of right valve with anterior tooth 3a and median cardinal tooth 1 short, narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; right posterior cardinal 3b long, straight, shallowly bifid subparallel to the nymph; socket for lateral AII long, narrow, moderately deep, smooth, parallel to the lunular border of the shell; socket for PII deep, bounded below by a rather large projecting tooth. Hinge of left valve with anterior cardinal 2a prominent, very slender, long, slightly concavely arched anteriorly, directed nearly vertically; left median cardinal 2b thicker than 2a, trigonal, directed obliquely backward; left posterior cardinal 4b parallel to ventral side of the nymph, twice as long as 2b, bladelike but sturdy; anterior lateral AII long, sturdy, hooked at its dorsal end, parallel to the hinge border below the lunule and the lunule margin, smooth sided except for fine striae along the upper dorsal edge; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the ligament groove. Pallial sinus broadly linguiform, angulate at the tip, extending to about the midline of the valve; dorsal arm barely ascending, nearly straight; ventral arm concavely ascending at about 50° to the ventral pallial line.

HOLOTYPE. CAS cat. no. 27838.15 [= CAS cat. no. 5788].

HYPOTYPES. USNM 456072 from USGS loc. M6981, near Chignik Lagoon, Alaska Peninsula, Alaska; LACMIP cat. nos. 8159 from UCLA loc. 3635, Chico Creek [11]; 8161 from UCLA loc. 3637, Chico Creek [11]; 8162 from UCLA loc. 3642, Chico Creek [11]; 8163 from UCLA loc. 3641, Chico Creek [11]; 8164–8165 from UCLA loc. 3643, Chico Creek [11]; 8168, 8170–8171 from LACMIP loc. 10834, Butte Creek [11], UCMP cat. no. 39834 (Gabb, 1864, pl. 23, fig. 141) from "Pence's Ranch" [11], Butte Co., California.

TYPE LOCALITY. CAS loc. 27838, Chico Creek [11], Butte Co., California (approx. 830 m above base of formation).

GEOLOGIC AGE. Early Campanian; associated with early occurrences of *Submortoniceras chicoense* (Trask, 1856).

DISTRIBUTION. Chignik Formation, Alaska Peninsula, Alaska; probably Pender Formation, Texada Island [1] and Vancouver Island [2], British Columbia; Chico Formation, Ten Mile Member, from approximately 600 m to 970 m above the base of the formation on Chico Creek [11], Butte Co.; Chico Formation, Ten Mile Member, Butte Creek [11], Butte Co.; Chico Formation, Pentz [11], Butte Co., California.

DIMENSIONS. See Table 12.

REMARKS. Anderson (1958) named but did not describe this species. The above description is based in part upon hypotypes from localities along Chico Creek [11] near the type locality. Popenoe (1964) considered *Calva* (*Egelicalva*) *buttensis* indistinguishable from C. (*E.*) *bowersiana*, but it is equally similar to C. (*E.*) *taffi*. The earliest C. (*E.*) *buttensis* are as difficult to distinguish from the preceeding C. (*E.*) *taffi* as are the latest from the succeeding C. (*E.*) *bowersiana*. *Calva* (*E.*) *buttensis* is transitional between C. (*E.*) *taffi*, which is relatively short and has a relatively large lunule and a narrower lateral tooth angle, and C. (*E.*) *bowersiana,* which is more elongate and has a more depressed lunule and a wider tooth angle. If preservation were better and the matrix more amenable, the striations on the lateral teeth might be more useful in distinguishing these species, as the striations are better developed on laterals of C. (*E.*) *taffi* than on laterals of C. (*E.*) *buttensis* and are lacking on mature C. (*E.*) *bowersiana.* The lunular margin of C. (*E.*) *taffi* is convex, that of C. (*E.*) *buttensis* is nearly straight, and that of C. (*E.*) *bowersiana* is concave. Gabb's (1864, pl. 23, fig. 141) three specimens of *Venus varians* var. ? from "Pence's Ranch," which are in the University of California, Berkeley, Museum of Paleontology, resemble the holotype of C. (*E.*) *buttensis.* The specimens from the Chignik Formation, near Chignik Bay, Alaska, are on the C. (*E.*) *taffi* end of this transition. They occur with *Inoceramus schmidti* Michael, 1899, and *Canadoceras newberryanum* Meek, 1857, which are found throughout the Chignik Bay section of the Chignik Formation and imply an early Campanian age (Jones, 1963).

Specimens identified as *Cytherea* (*Caryatis*) *plana* (Sowerby, 1812) by Whiteaves (1879, p. 149) and as *Cytherea leonensis* Conrad by Etheridge *in* Hector (1861) from the Pender Formation are probably *Calva* (*Egelicalva*) *buttensis.* The true *Cytherea* (*Caryatis*) *plana* lacks posterior laterals and is the type of *Callistina* Jukes-Brown, 1908. In 1903, Whiteaves referred all of these specimens from the Nanaimo vicinity to *Meretrix nitida* Gabb.

Calva (*Egelicalva*) *bowersiana* (Cooper, 1894)

Figures 211–238

? *Cytherea* (*Caryatis*) *plana* (Sowerby) Whiteaves, 1879, p. 149, in part, probably pl. 17, fig. 14–14b. Not *Venus planus* Sowerby, 1812.

Cucullaea bowersiana Cooper, 1894, p. 48, pl. 5, figs. 61–62; Coan, 1981, p. 152.

Meretrix nitida Gabb Whiteaves, 1903, p. 377, in part. Not *Meretrix nitida* Gabb, 1864.

Chione varians (Gabb) Waring, 1917, p. 8, fig. 13. Not *Venus varians* Gabb, 1864. Specimen not found, not transferred from Stanford to California Academy of Sciences.

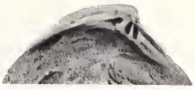
Meretrix nitida var. *major* Packard, 1922, p. 425, pl. 31, fig. 2.

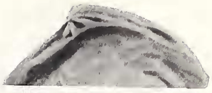
Meretrix (?) sp. Packard, 1922, p. 426, pl. 33, fig. 2.

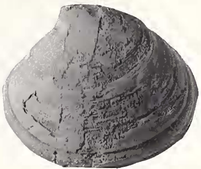
Calva bowersiana (Cooper) Popenoe, 1937, p. 396; Popenoe, 1954, p. 17, fig. 3 (10); Stadum, 1973, pl. II, fig. 2; Popenoe, 1973, p. 22, pl. 3, fig. 32; Saul and Alderson, 1981, p. 32, pl. 2, fig. 12.

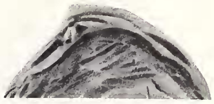
"*Meretrix*" *coronada* Anderson, 1958, p. 136.

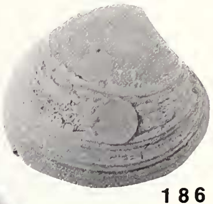
DIAGNOSIS. A large, ovately trigonal *Egelicalva* having smooth lateral teeth and the lunular margin concave. Cardinal tooth 1 barely extending to hinge plate edge, extending farther toward beak than 3a, 3a shorter than 1, hinge plate relatively narrow.

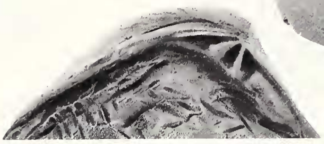

182

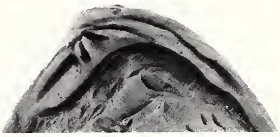

183

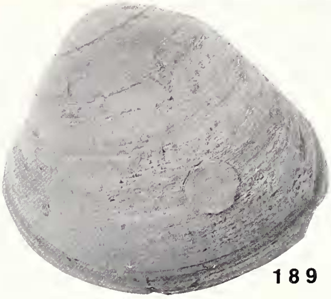

184

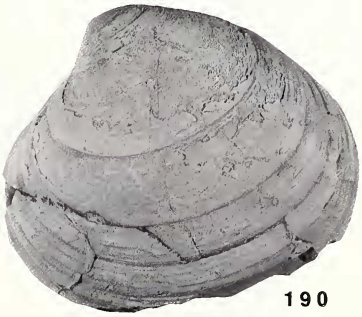

185


186

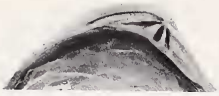

187

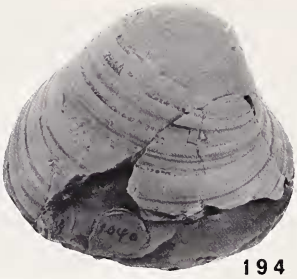

188

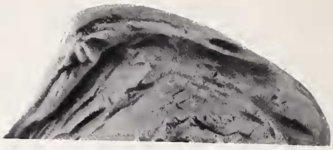

189

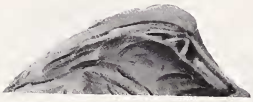

190

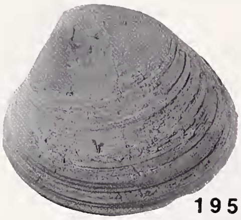
Figures 182–190. *Calva* (*Egelicalva*) *taffi* (Anderson). All hypotypes; all of late Santonian age; all specimens whitened with ammonium chloride. **182, 184, 186,** LACMIP cat. no. 8156, ×1, from UCLA loc. 4217, **182,** hinge, **184,** exterior, **186,** exterior. **183,** LACMIP cat. no. 8138, ×1.5, from UCLA loc. 3627, hinge. **185,** LACMIP cat. no. 8155, ×1, from UCLA loc. 4217, hinge. **187, 189,** LACMIP cat. no. 8136, ×1, from UCLA loc. 3627, **187,** hinge, **189,** exterior. **188, 190,** LACMIP cat. no. 8137, ×1, from UCLA loc. 3627, **188,** hinge, **190,** exterior. Photos 182, 184, 190 by De Leon; 183, 185–189 by Saul.

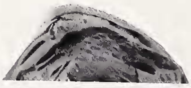

191

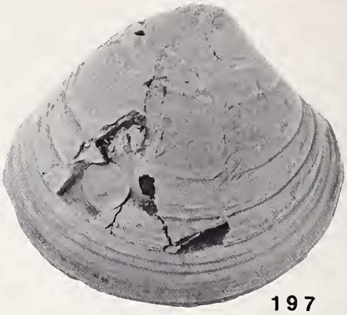

194

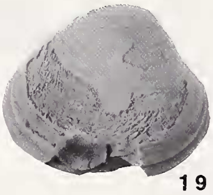

192

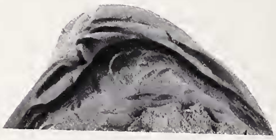

193

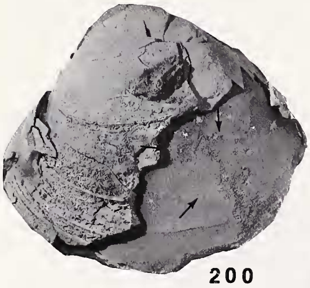

195

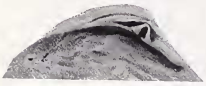

196

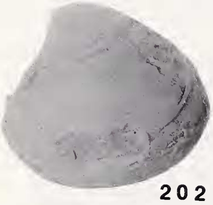

197

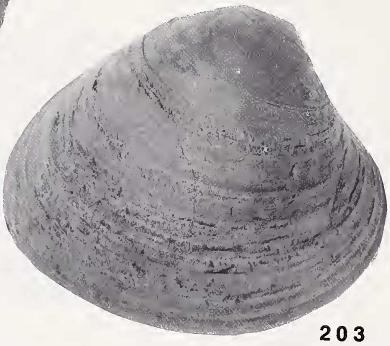

198

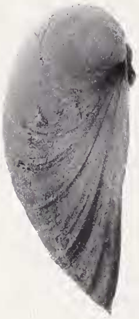

199

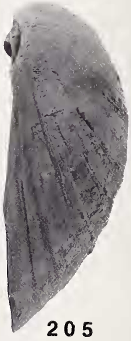

200

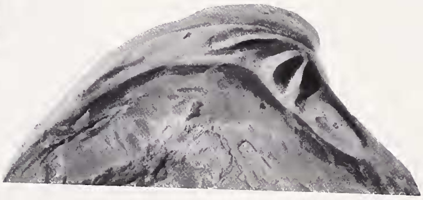

201

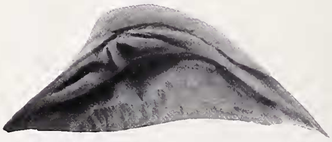

202

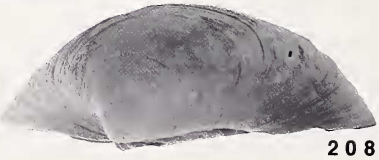

203

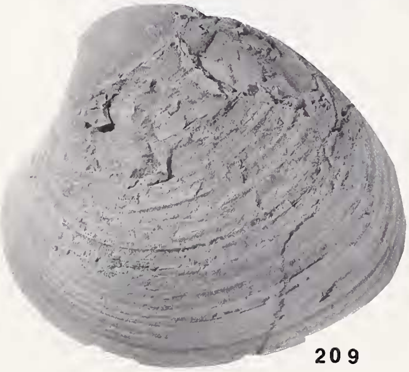

204


205


206


207


208


209

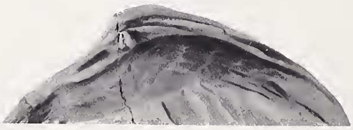

210

Table 12. Measurements of *Calva* (*Egelicalva*) *buttensis*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
CAS 27838.15	41.0	48.4	16.0	20.4	11.5	3.4	117°	1.2	3.0	2.4	1.8	3.3
LACMIP 8159	38.5	43.7	14.9	18.0	13.0	3.6	100°	1.1	2.9	2.4	1.4	3.6
LACMIP 8161	29.7	34.8	11.2	15.0	10.0	3.2	118°	1.2	3.1	2.3	1.5	3.1
LACMIP 8164	24.8	28.0	9.8	14.4			107°	1.1	2.9	1.9	—	—
LACMIP 8165	21.6	26.4	8.9	13.0	7.0	2.2	126°	1.2	3.0	2.0	1.9	3.2
LACMIP 8168	27.0	30.0	12.0	14.4	9.4	2.6	94°	1.1	2.5	2.1	1.5	3.6
LACMIP 8170	33.7	36.4	15.3	17.5	10.0	4.0	98°	1.1	2.4	2.1	1.8	2.5
LACMIP 8171	22.5	26.3	10.5	14.4	8.7	2.8	101°	1.2	2.5	1.8	1.6	3.1
USNM 456072	31.6	38.5	12.5	27.8	11.4	3.0	110°	1.2	3.1	1.4	2.4	3.8

DESCRIPTION. Shell of moderate to large size, nearly as high as long, inflated, thick; beaks prominent, rather high, placed anterior to the mid-length of the shell, prosogyrous; lunular border slightly concave; anterior end rounded; ventral border broadly arched; posterior end rounded; posterior dorsal border slightly arched; lunule moderately large, impressed, delimited by an inscribed line; escutcheon very narrow, defined by angulation only near the beak.

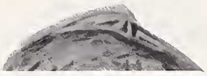
Ligament groove long, deep, arcuate behind smooth nymphs. Hinge of right valve with anterior tooth 3a very short and median cardinal tooth 1 short, narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; right posterior cardinal 3b long, slightly arched, shallowly bifid subparallel to the nymph; socket for lateral AII long, narrow, deep, smooth, parallel to the lunular border of the shell; socket for PII moderately deep, long, bounded below by a rather large projecting tooth PI; PI aligned with nymph. Hinge of left valve with anterior cardinal 2a prominent, slender; cardinal 2b trigonal, thicker and shorter than 2a, directed obliquely backward; posterior cardinal 4b parallel to nymph, nearly twice as long as 2b, bladelike; anterior lateral AII long, hooked at its dorsal end, parallel to the lunular margin, smooth sided; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the posterior end of the ligament groove. Pallial sinus broadly linguiform, extending across two-fifths of the valve length; dorsal arm nearly horizontal; ventral arm ascending concavely at angle of about 45° to the pallial line. Adductor muscle scars moderately impressed, rounded.

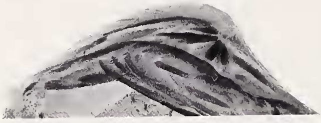
LECTOTYPE. CAS cat. no. 66028.01 (= CAS 615; ex CSMB 13734) herein designated. Popenoe (1937, p. 397) recognized this specimen as the one figured by Cooper and considered it to be the holotype, but Coan (1981, p. 153) regarded it as a syntype.

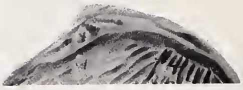
HYPOTYPES. UCMP cat. nos. 12279 (holotype of *Meretrix nitida* var. *major* Packard) from UCMP loc. 2179, Santa Ana Mountains [26]; 12306 (hypotype of *Meretrix* (?) sp. of Packard, 1922, and holotype of "*Meretrix*" *coronada* Anderson, 1958) from UCMP loc. 2167, Santa Ana Mts. [26], Orange Co., California. UCLA cat. nos. 28710 from LACMIP loc. 10715 [= CIT loc. 86], Santa Ana Mts. [26]; 59076 from UCLA loc. 4207, Santa Ana Mts. [26], Orange Co.; 59214 from LACMIP loc. 10715 [= CIT loc. 1159], Simi Hills [24], Los Angeles Co., California. LACMIP cat. nos. 8173 from UCLA loc. 3976, E of Glenn Cove [14], Solano Co.; 8176 from UCLA loc. 3648, "Fossil Bluff," Chico Creek [11]; 8178–8181 from LACMIP loc. 10861 [= CIT loc. 1183], "Fossil Bluff," Chico Creek [11], Butte Co.; 8182 from LACMIP loc. 10719, Santa Ana Mts. [26]; 8184 from LACMIP loc. 10120 [= CIT loc. 86], Santa Ana Mts. [26]; 8185 from LACMIP loc. 10105 [= CIT loc. 974], Santa Ana Mts. [26], Orange Co.; 8187 from LACMIP loc. 10715 [= CIT

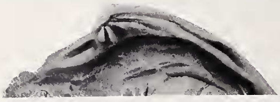
←

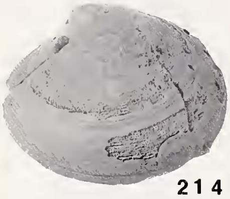
Figures 191–210. *Calva* (*Egelicalva*) *buttensis* (Anderson). All ×1; except as indicated, all specimens whitened with ammonium chloride. **191, 195,** LACMIP cat. no. 8168, hypotype, from LACMIP loc. 10834, **191,** hinge, **195,** exterior. **192, 198,** LACMIP cat. no. 8159, hypotype, from UCLA loc. 3635, **192,** hinge, **198,** exterior. **193,** LACMIP cat. no. 8161, hypotype, from UCLA loc. 3637, hinge. **194, 199,** LACMIP cat. no. 8170, hypotype, from LACMIP loc. 10834, **194,** exterior, **199,** hinge. **196,** LACMIP cat. no. 8171, hypotype, from LACMIP loc. 10834, hinge. **197,** LACMIP cat. no. 8171, hypotype, from LACMIP loc. 10834, exterior. **200,** LACMIP cat. no. 8162, hypotype, from UCLA loc. 3642, pallial sinus, without whitening. **201,** LACMIP cat. no. 8165, hypotype, from UCLA loc. 3643, hinge. **202,** LACMIP cat. no. 8164, hypotype, from UCLA loc. 3643, exterior. **203–205, 207, 208,** CAS cat. no. 27838.15, holotype, from CAS loc. 27838, **203,** exterior, **204,** anterior view, **205,** posterior view, **207,** hinge, **208,** dorsal view. **206, 209,** USNM cat. no. 456072, hypotype, from USGS loc. M6981, **206,** hinge, **209,** exterior. **210,** LACMIP cat. no. 8163, hypotype, from UCLA loc. 3641, hinge. Photos 191, 195, 201, 206, 209 by De Leon; 192–194, 196–200, 201–205, 207, 208, 210 by Saul.

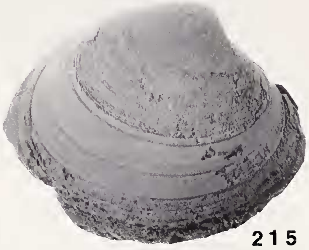

211

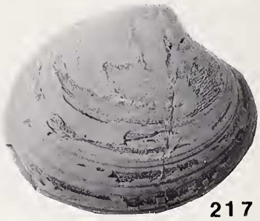

212

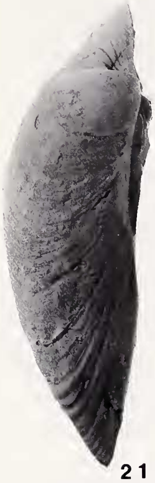

213

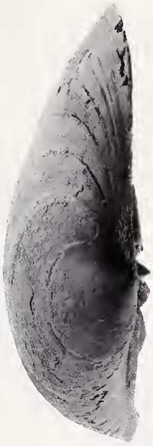

216

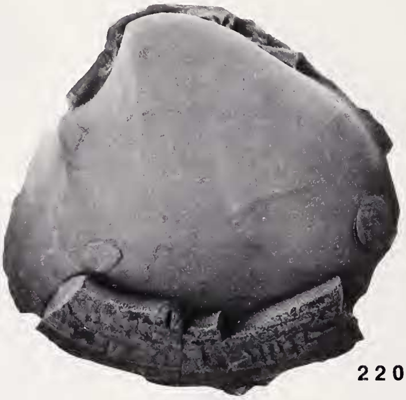

214

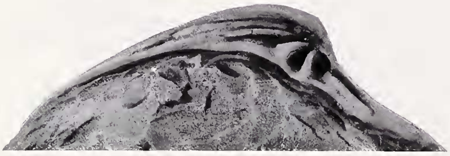

215

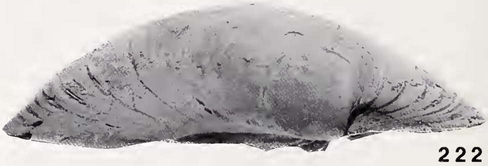

217

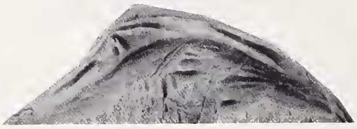

218

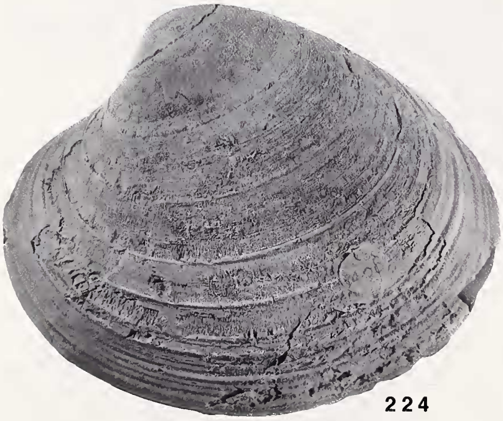

219

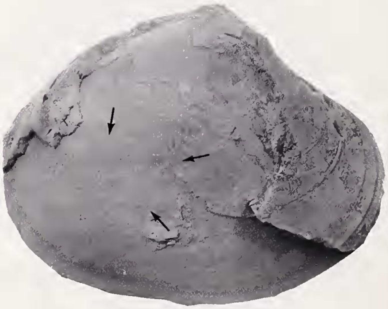

220


221


222


223


224


226

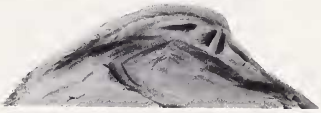

225

Table 13. Measurements of *Calva* (*Egelicalva*) *bowersiana*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
UCLA 28710	62.5	68.0	24.6					1.1	2.8	—	—	—
UCLA 59076	60.0	67.5	20.0					1.1	3.4	—	—	—
UCLA 59214	46.7	53.7	19.2					1.2	2.8	—	—	—
LACMIP 8173	39.0	48.0	13.7	19.7	8.7	3.7	124°	1.2	3.5	2.4	2.3	2.4
LACMIP 8176			15.8	27.0	11.4	3.7	109°	—	—	—	2.4	3.1
LACMIP 8178	32.0	39.4	11.8	18.7	7.8	2.4	113°	1.2	3.3	2.1	2.4	3.2
LACMIP 8179	27.5	33.4	11.0	15.0	7.5	2.0	112°	1.2	3.0	2.2	2.0	3.8
LACMIP 8180	23.5	28.8	10.0	14.0	6.0	1.8	126°	1.2	2.9	2.1	2.3	3.3
LACMIP 8182	36.0		13.4	20.5	9.3	2.3	112°	—	—	—	2.0	4.0
LACMIP 8184	48.9	61.0	18.0	22.5	13.0	4.6	114°	1.2	3.4	2.7	1.7	2.8
LACMIP 8185	59.8		22.6	34.0			105°	—	—	—	—	—
LACMIP 8187	62.7		23.2	33.9	18.0	6.0	97°	—	—	—	1.9	3.0
LACMIP 8192	47.2	57.0	15.5	28.0	12.7	3.0	111°	1.2	3.7	2.0	2.2	4.2

loc. 1159], Dayton Canyon [24], Los Angeles Co.; 8192 from LACMIP loc. 10446 [= CIT loc. 1400], Sucia Island, San Juan Co., Washington. Whiteaves' specimen of *Cytherea* (*Caryatis*) *plana* (Sowerby) from 2¼ miles up the Nanaimo River [2], Vancouver Island, British Columbia, and Waring's specimen of *Chione varians* (Gabb) from "loc. 3, south of the Santa Monica Mts." [25], Los Angeles Co., California, are missing.

TYPE LOCALITY. "Cretaceous of Santa Ana Mountains" (Cooper, 1894) [26], Orange Co., California. Of *Meretrix nitida* var. *major,* UCMP loc. 2169, ½ mile south 50° east of B.M. 1271, Corona Sheet. On crest of Santiago–Aliso divide, about ¼ mile north of the road (Packard, 1922, p. 416) [26]. Of "*Meretrix*" *coronada,* UCMP loc. 2167, 2 miles north 10° west of B.M. 1271, Corona Sheet. At a gate about ½ mile below Modjeska Springs in Williams Canyon (Packard, 1922, p. 416) [26].

GEOLOGIC AGE. Late early through late Campanian; associated with late occurrences of *Submortoniceras chicoense* (Trask, 1856) and with *Hoplitoplacenticeras vancouverense* (Meek, 1862) and *Metaplacenticeras* cf. *M. pacificum* (Smith, 1900). The matrix of the lectotype has an impression of a *Turritella chicoensis pescaderoensis* Arnold, 1908, a subspecies of late Campanian age (Saul, 1983).

DISTRIBUTION. Cedar District Formation on Sucia Island [3], San Juan Co., Washington; Great Valley Series, near Benicia [14], Solano Co.; Pigeon Point Formation near Bolsa Point [16], San Mateo Co.; Chatsworth Formation, Simi Hills [24], Los Angeles Co.; Tuna Canyon Formation, Santa Monica Mts. [25], Los Angeles Co.; Williams Formation, Pleasants Sandstone Member, Santa Ana Mts. [26], Orange Co., California.

DIMENSIONS. See Table 13.

REMARKS. Cooper (1894) wrote that he had "many" specimens of this species from the Santa Ana Mountains [26], collected by Dr. Stephen Bower, but only the specimen figured by Cooper, CAS cat. no. 615 = CAS 66028.01, is extant (Coan, 1981, p. 152). Popenoe (1937) found that some matrix had been removed from this specimen exposing the beak and making possible its identification with the common *Calva* of the Pleasants Sandstone in the Santa Ana Mountains [26]. The species is widespread and abundant at many localities.

Calva bowersiana is slightly more elongate than *C. buttensis* and has a more concave lunular margin. Specimens from near the top of the Ten Mile Member of the Chico Formation on Chico Creek have a somewhat more concave lunular margin and shorter anterior laterals than does typical *C.* (*Egelicalva*) *buttensis* and are referred to *C.* (*E.*) *bowersiana,* although at least one specimen from LACMIP loc. 10861, "Fossil Bluff," has very fine striations on a longitudinal ridge on the dorsally facing side of the anterior lateral socket and on an

←

Figures 211–226. *Calva* (*Egelicalva*) *bowersiana* (Cooper). All hypotypes; all ×1; all from early Campanian zones of *Submortoniceras chicoense* or *Hoplitoplacenticeras vancouverense*; all specimens whitened with ammonium chloride. **211, 214,** LACMIP cat. no. 8180, from LACMIP loc. 10861, **211,** hinge, **214,** exterior. **212,** LACMIP cat. no. 8176, from UCLA loc. 3648, hinge. **213, 217,** LACMIP cat. no. 8179, from LACMIP loc. 10861, **213,** hinge, **217,** exterior. **215, 216,** LACMIP cat. no. 8178, from LACMIP loc. 10861, **215,** exterior, **216,** hinge. **218, 219, 221, 222, 224,** LACMIP cat. no. 8192, from LACMIP loc. 10446, **218,** posterior view, **219,** anterior view, **221,** hinge, **222,** dorsal view, **224,** exterior. **220,** LACMIP cat. no. 8181, from LACMIP loc. 10861, pallial sinus. **223, 226,** LACMIP cat. no. 8173, from UCLA loc. 3976, **223,** hinge, **226,** pallial sinus. **225,** LACMIP cat. no. 8182, from LACMIP loc. 10719, hinge. Photos 211–217, 220, 223, 225, 226 by Saul; 218, 219, 221, 222, 224 by De Leon.

arcuate slanting ridge on the dorsally facing side of the posterior lateral socket. Specimens from this horizon (Figs. 211, 213–217) have a less depressed lunule and are less inflated than typical C. (*E.*) *bowersiana* of the *Metaplacenticeras pacificum* Zone (Figs. 228–233). Specimens from Sucia Island [3] (Figs. 218, 219, 221, 222) have a wider lateral tooth angle than those from the Pleasants Sandstone in the Santa Ana Mountains [26] and, except for a slightly more concave lunular margin, resemble those from the top of the section on Chico Creek [11]. Specimens from the base of the Schultz Conglomerate in the Santa Ana Mountains [26] are also intermediate between C. (*E.*) *buttensis* and C. (*E.*) *bowersiana.*

Anderson (1958) figured a specimen of *Calva crassa* as *Trigonocallista major* (Packard), although Popenoe (1937) had shown that *T. major* is a junior synonym of C. (*Egelicalva*) *bowersiana. Calva* (*E.*) *bowersiana* is more elongate, has a less strongly arched hinge plate, and is less inflated than C. (*E.*) *crassa.* Cardinals 2a and 2b of C. (*E.*) *bowersiana* are more divergent than those of C. (*E.*) *crassa.* Anderson (1958) also provided the new name *Meretrix coronada* for *Meretrix* (?) sp. of Packard (1922). The specimen figured by Packard (UCMP cat. no. 12306) has been rendered unduly elongate for C. (*E.*) *bowersiana* by post-depositional crushing. It retains shell mainly on the anterior and displays, as noted by Packard, a lunule bounded by an incised line (Fig. 235). Its pallial sinus can be discerned on the right valve steinkern (Fig. 238); these two features indicate that it is C. (*E.*) *bowersiana.* Anderson (1958, p. 137) suggested that "*M.*" *coronada* was congeneric with "*Meretrix*" *marshana* Anderson, 1958, but "*M.*" *marshana,* which appears to have had alate nymphs, is probably not a venerid.

The holotype of *Cyprina denmanensis* Whiteaves, 1903 (p. 380, fig. 25) from the west side of Denman Island, British Columbia, lacks the hinge and part of the beak area. It has a growth line suggestive of *Calva* (*Egelicalva*) *bowersiana* but is at least half again as large as any other specimen of C. (*E.*) *bowersiana.* J. M. Haggart has sent two specimens from GSC loc. 83909 on the southern shore of Denman Island, which he suggested might be *Cyprina denmanensis.* Both specimens are bivalved and neither is as large as the holotype. These specimens do not appear to belong in the Veneridae; what can be seen of their hinges suggests that they are mactrids.

Certainly some of *Cytherea* (*Caryatis*) *plana* (Sowerby, 1812) of Whiteaves (1879, p. 149) are *Calva* (*Egelicalva*) *bowersiana* (Cooper). Unfortunately Whiteaves' figured specimens have not been recognized and are not in the collections of the Geological Survey of Canada. His illustrations resemble C. (*E.*) *bowersiana* from Sucia Island. Four small specimens, GSC cat. nos. 5716, a–c from the northwest side of Hornby Island, may belong in *Calva* (*Microcalva*). They resemble *Calva* (*Microcalva*) *haggarti* but have concentric sculpture only near the beak, confined to the area circumscribed by the first growth check. They may be juvenile C. (*E.*) *bowersiana* but are too incomplete for certain identification. Specimens from the Cedar District Formation on Sucia Island [3], although in some respects intermediate between C. (*E.*) *bowersiana* and C. (*E.*) *buttensis,* are considered to be C. (*E.*) *bowersiana* because of their concave lunular margin. Judging from the inferred ages of the deposits, some of Whiteaves' other specimens are probably *Calva* (*E.*) *bowersiana* (Cooper), but they can best be reassigned when the specimens have been recovered. In 1903, Whiteaves included all of these specimens in *Meretrix nitida* Gabb, but none are likely to be *M. nitida,* which is of late Albian–Cenomanian age.

Calva (*Egelicalva*) *bowersiana* occurs in the Pigeon Point Formation near Bolsa Point [16], San Mateo Co., California. On the basis of a paleomagnetic study, the Pigeon Point Formation has been considered to have been deposited at about 21°N latitude off the coast of southern Mexico (Champion et al., 1981). If the provenance of the Pigeon Point specimens is near 21°N, the geographic range of C. (*E.*) *bowersiana* is extended southward by about 13°. Neither C. (*E.*) *bowersiana* nor any other species in the fauna is known from the Mexican mainland, but several Pigeon Point species, *Cucullaea* (*Idonearca*) *youngi* (Waring, 1917), *Turritella chicoensis pescaderosensis* Arnold, 1908, and *Tessarolax distorta* Gabb, 1864, also occur in deposits of late Campanian age in the Santa Monica [25] and Santa Ana [26] Mountains.

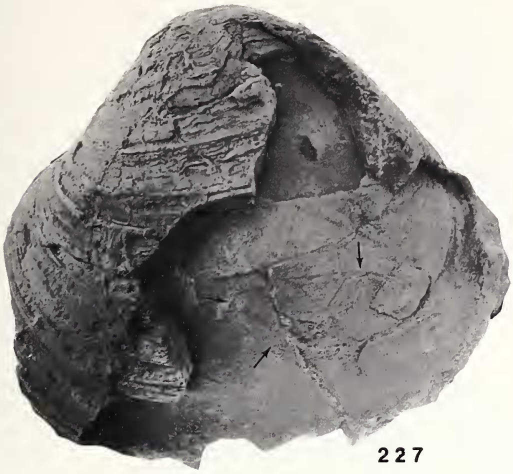
Calva (*Egelicalva*) *crassa,* new species

Figures 239–254

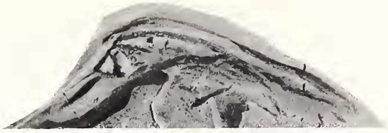
Venus steineyi Hertlein Anderson and Hanna, 1935, p. 7 (n. nud.).

→

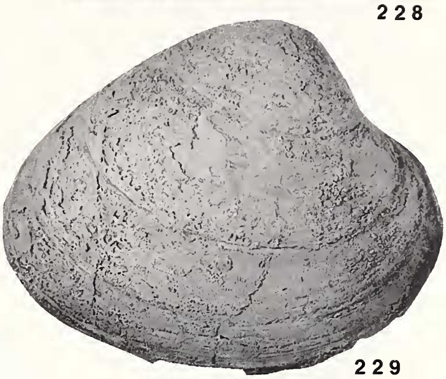
Figures 227–238. *Calva* (*Egelicalva*) *bowersiana* (Cooper). All ×1; all from zone of *Metaplacenticeras pacificum*; all specimens whitened with ammonium chloride. **227,** CAS cat. no. 66028.01, holotype, from CAS loc. 66028, exterior. **228, 229, 231–233,** LACMIP cat. no. 8184, hypotype, from LACMIP loc. 10120, **228,** hinge, **229,** exterior, **231,** dorsal view, **232,** anterior view, **233,** posterior view. **230,** LACMIP cat. no. 8185, hypotype, from LACMIP loc. 10105, hinge. **234, 236, 237,** LACMIP cat. no. 8187, hypotype, from LACMIP loc. 10715, **234,** anterior view, **236,** dorsal view, **237,** hinge. **235, 238,** "*Meretrix*" *coronada* Anderson, UCMP cat. no. 12306, holotype, from UCMP loc. 1267, **235,** dorsal view, **238,** right valve pallial sinus. Photos 227, 236 by Saul; 228–235, 237, 238 by De Leon.



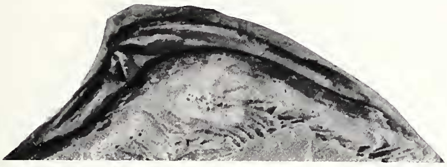
227



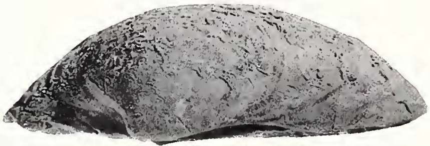
228



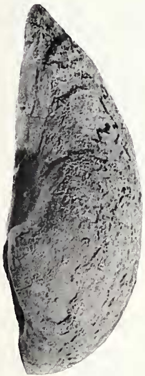
229



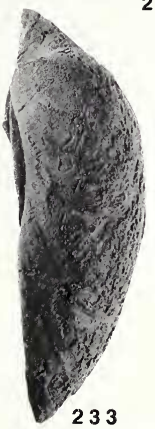
230



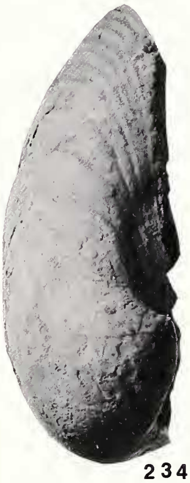
231



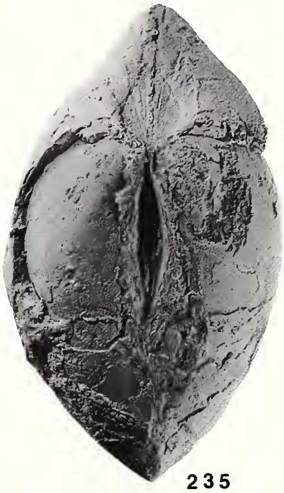
232



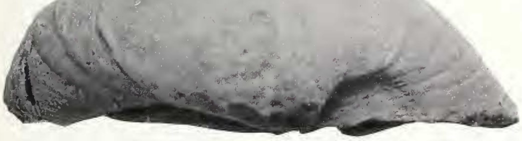
233



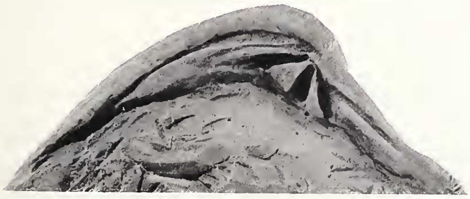
234



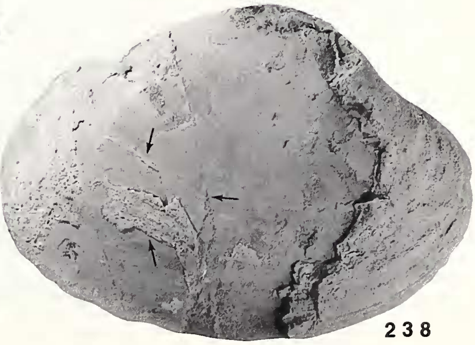
235



236



237



238

Calva "*steineyi*" Hertlein MSS Popenoe, 1954, p. 17, fig. 4 (12).

Trigonocallista major (Packard) Anderson, 1958, p. 138, pl. 70, fig. 2–2a. Not *Meretrix nitida major* Packard, 1922 = *Calva bowersiana* (Cooper).

Calva varians (Gabb) Dailey and Popenoe, 1966, p. 16, pl. 4, figs. 1–4; Saul, 1970, p. 80, fig. 16. Not *Venus varians* Gabb, 1864; *Aphrodina varians* (Gabb) Stewart, 1930; "*Trigonocallista*" *varians* (Gabb) Anderson, 1958.

DIAGNOSIS. A large, relatively high, broad-beaked *Egelicalva* with maximum inflation anterior to the mid-length, a concave lunular margin, and smooth lateral teeth. Cardinal tooth 1 not reaching the hinge plate edge, extending farther toward beak than 3a.

DESCRIPTION. Shell thick, of large size, nearly as high as long, inflated, maximum inflation anterior to mid-length; beaks prominent, high, anterior to the mid-length of the shell, strongly prosogyrous; lunular margin strongly concave; anterior end broadly rounded; ventral border slightly arched, medially flattened; posterior end angulately truncate; posterior dorsal border long, slightly arched in small specimens, moderately arched in large specimens; lunule large, wide, deep, delimited by an inscribed line; escutcheon indistinct; shell surface marked by growth lines and distant, impressed growth checks.

Ligament groove arched, nymphs salient posteriorly. Hinge of right valve with anterior tooth 3a short, narrow, prominent, close to 1; median cardinal 1 a third longer than 3a, narrow, prominent, diverging ventrally from 3a, situated directly beneath the beak; posterior cardinal 3b long, arched, shallowly bifid subparallel to the nymph; socket for lateral AII long, deep, smooth, parallel to the lunular border of the shell; socket for PII long, deep, bounded below by PI. Hinge of left valve with anterior cardinal 2a prominent, very slender, directed slightly posteriorly; cardinal 2b thicker than 2a, trigonal, directed obliquely backward, slightly arched; posterior cardinal 4b separated from the nymph by a groove, scarcely longer than the anterior teeth; anterior lateral AII long, hooked posteriorly, parallel to the lunular margin, smooth sided; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus broadly linguiform, extending to near the valve mid-length; dorsal arm nearly horizontal; ventral arm concavely ascending, at an angle of near 40° to pallial line. Anterior adductor muscle scar well impressed, rounded; posterior adductor muscle scar moderately impressed, rounded.

HOLOTYPE. UCLA cat. no. 40421 [= hypotype of *Calva varians* (Gabb) of Dailey and Popenoe, 1966, p. 16, pl. 4, figs. 1–2, 4].

PARATYPES. UCLA cat. nos. 28711 [= "hypotype" of *Calva* "*steineyi*" Hertlein MSS of Popenoe, 1954, p. 19, fig. 4 (12)] from LACMIP loc. 10690 [= CIT loc. 590], Jalama area [22]; 40422 [= hypotype of *C. varians* (Gabb) of Dailey and Popenoe, 1966, p. 16, pl. 4, fig. 3] from UCLA loc. 4118, Jalama area [22]; 59081 [= hypotype of *C. varians* (Gabb) of Popenoe, 1973, p. 24, pl. 4, fig. 41] from UCLA loc. 4143, Jalama area [22], Santa Barbara Co., California. LACMIP cat. nos. 8174 from UCLA loc. 4120, Jalama Creek [22]; 8177 from UCLA loc. 4116, Jalama Creek [22]; 8198 from LACMIP loc. 10695, Jalama Creek [22], Santa Barbara Co.; 8199 from UCLA loc. 6345, 2 miles south of Ortigalita Creek [18], Merced Co.; 8233 from UCLA loc. 4131, Jalama Ranch [22], Santa Barbara Co., California. CAS cat. no. 10645 from CAS loc. 954 (hypotype of *Trigonocallista major* (Packard) of Anderson, 1958) from Punta Banda [29], Baja California, Mexico.

TYPE LOCALITY. UCLA loc. 4118, Jalama area [22], Santa Barbara Co., California.

GEOLOGIC AGE. Early Maastrichtian.

DISTRIBUTION. Moreno Formation, Tierra Loma Sandstone, Ortigalita Peak Quadrangle [18], Merced Co.; cobble in ?El Piojo Formation, at Pebblestone Shut-In [21], San Luis Obispo Co.; Jalama Formation, near Jalama Creek [22], Santa Barbara Co., California; Chatsworth Formation, west end of the Simi Hills [24], Ventura Co., California; Rosario Formation, Punta Banda [29], Baja California, Mexico.

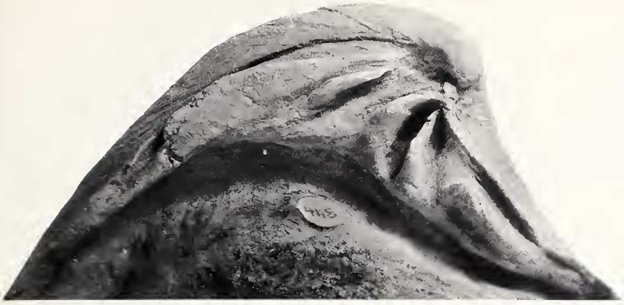
DIMENSIONS. See Table 14.

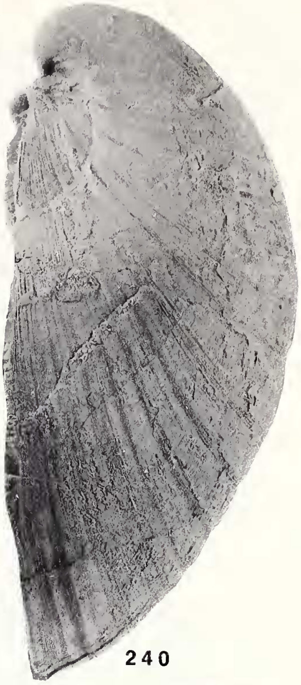
REMARKS. In some specimens the valves are unevenly inflated and the anterior more inflated part is set off from the posterior by a shallow arching sulcus that extends from about ¼ valve height to the ventral margin (Fig. 250). *Calva* (*Egelicalva*) *crassa* and *C.* (*Penecallista*) *marina* are both large, but *C.* (*E.*) *crassa* is relatively much higher and more inflated and has a larger lunule than *C.* (*P.*) *marina*. *Calva* (*E.*) *crassa* has a typical *Calva* hinge, but *C.* (*P.*) *marina* has 2b short, extending no more than two-thirds across the hinge plate. In shape *C.* (*E.*) *crassa* resembles *C.* (*E.*) *taffi* but has a more concave lunular border, and all specimens of *C.* (*E.*) *taffi* are much smaller. *Calva* (*E.*) *crassa* has been confused with *C.* (*C.*) *varians* from which it

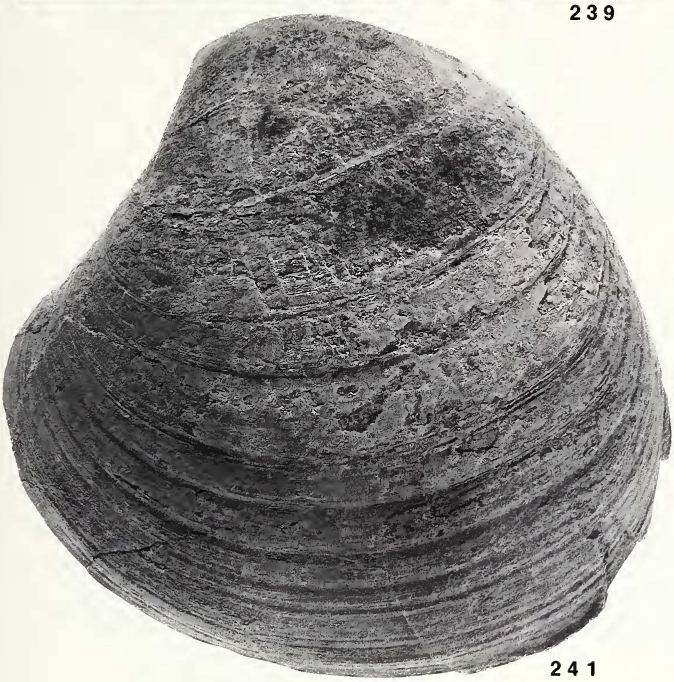
---

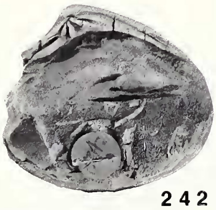
→

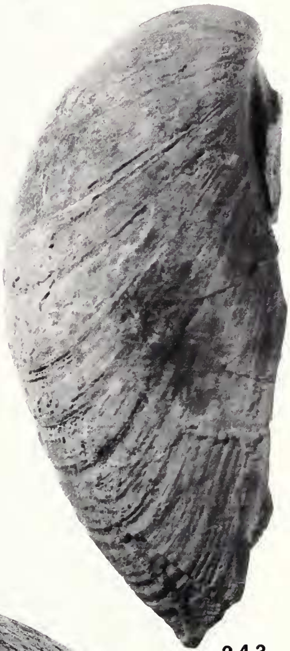
Figures 239–245. *Calva* (*Egelicalva*) *crassa,* new species. All ×1; all specimens whitened with ammonium chloride. **239–241, 243, 245,** UCLA cat. no. 40421, holotype, from UCLA loc. 4118, **239,** hinge, **240,** anterior view, **241,** exterior, **243,** posterior view, **245,** dorsal view. **242,** LACMIP cat. no. 8174, paratype, from UCLA loc. 4120, hinge. **244,** LACMIP cat. no. 8233, paratype, from UCLA loc. 4131, exterior. Photos 239–241, 245 by Susuki; 242–244 by De Leon.

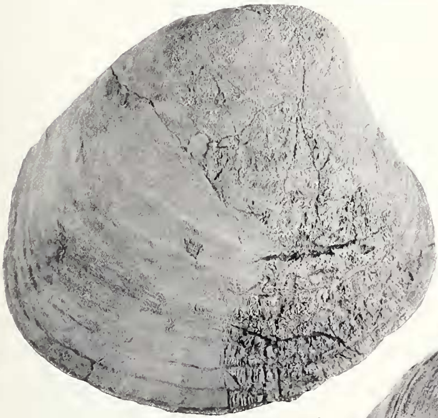

239


240


241


242


243


244

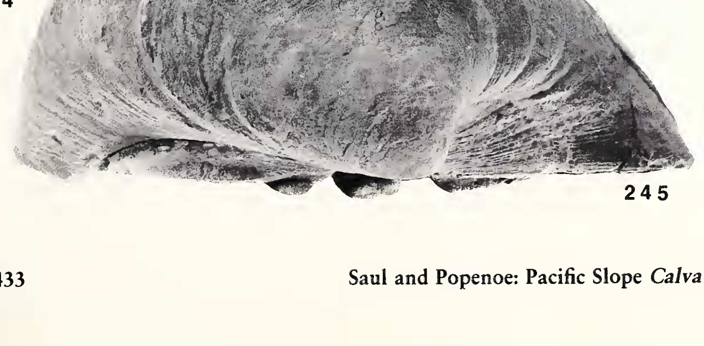

245

Table 14. Measurements of *Calva* (*Egelicalva*) *crassa*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
UCLA 28711	89.4	98.7	36.4	39.4	23.8	9.4		1.1	2.7	2.5	1.66	2.5
UCLA 40421	83.6	87.8	36.8	40.5	24.0	9.2	93°	1.0	2.4	2.2	1.7	2.6
UCLA 40422	82.0	85.0	34.4	42.2	22.8	11.0	93°	1.0	2.5	2.0	1.8	2.1
UCLA 59081	80.0	85.8	32.6					1.1	2.6	—	—	—
LACMIP 8177	80.5	85.0	30.8	32.0	17.0	8.6		1.1	2.8	2.7	1.9	2.0
LACMIP 8198	54.5	59.0	20.0	28.7	15.0	4.7	108°	1.1	3.0	2.1	1.9	3.2
LACMIP 8233	58.0	60.5	17.0	26.0	13.5	5.0		1.0	3.6	2.3	1.9	2.7

differs in being relatively higher and having a much wider, deeper, and more heart-shaped lunule and a concave lunular border.

The specimen figured by Anderson (1958, pl. 70, fig. 2–2a) as *Trigonocallista major* Packard is the same specimen earlier called *Venus steineyi* Hertlein by Anderson and Hanna (1935). According to Anderson and Hanna it was collected at Punta Banda [29], Baja California. Although Hertlein never described the species, the name "*steineyi*" was used for this large, robust *Calva* for more than two decades.

Several specimens from a large boulder (LACMIP loc. 12245) in a conglomerate that crops out at the Pebblestone Shut-In [21], San Luis Obispo Co., California, are probably this species as are poorly preserved specimens from at least two localities near Ortigalita Creek [18], Merced Co., California. At one of these localities *Calva* (*Calva*) *varians* is also present, and the temporal ranges of these two species apparently overlapped somewhat.

ETYMOLOGY. The specific name is from Latin, *crassus*, large.

Subgenus *Microcalva*, new subgenus

TYPE SPECIES. *Calva* (*Microcalva*) *haggarti*, new species.

DIAGNOSIS. Small ovately trigonal *Calva* with concentric ribs and lacking a distinct escutcheon. Hinge moderately heavy with 3b narrowly bifid, laterals finely striate, and anterior lateral AII hooked. Pallial sinus linguiform.

DISCUSSION. Hinges of these small venerids are essentially similar to those of *Calva*. *Microcalva* differs from other *Calva* in its small size and in having the polished shell surface sculptured with fine concentric ribs. Compared to other *Calva* of equivalent age its laterals are more strongly striated. Juveniles up to the first growth check of *Egelicalva* are most similar to *Microcalva*, and specimens of *Microcalva* might be considered to be just juveniles of an *Egelicalva* if *Calva* (*Microcalva*) *haggarti* were not so abundant in the Cedar District Formation of the Nanaimo Basin. *Microcalva* is clearly more closely related to *Egelicalva* than to *Calva* s.s. In size and sculpture *Microcalva* is suggestive of *Loxo* Dailey and Popenoe, 1966, but *Microcalva* has round-topped ribs rather than the inscribed lines of *Loxo*. The hinge of *Microcalva* has the anterior lateral AII posteriorly hooked and parallel to the lunular margin as in *Calva*, whereas that of *Loxo* is straight and at an angle to the lunular margin. *Microcalva* resembles *Chimela* Casey, 1952, in lacking an escutcheon but differs in having a well-developed posterior hook to anterior lateral AII. AII is quite long in *Microcalva*, and the pallial sinus is long and linguiform.

ETYMOLOGY. The subgeneric name is compounded from *mikros*, Greek, small, little, and *Calva* and is of feminine gender.

Calva (*Microcalva*) *elderi*, new species

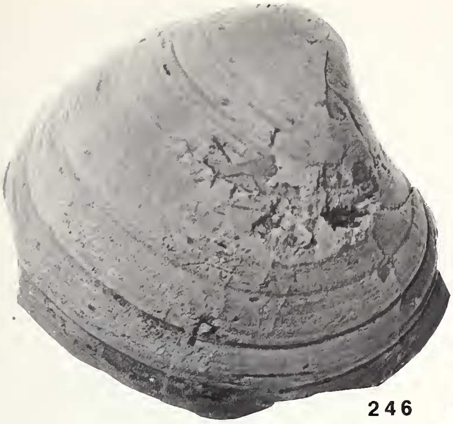
Figures 255–261

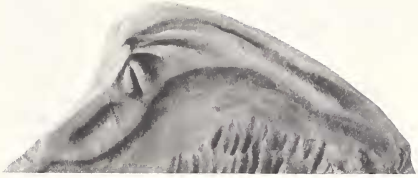
DIAGNOSIS. An anteriorly produced *Microcalva* with moderately broad concentric ribs that are steeper on the dorsal side. Hinge with cardinal 3b elongate and lateral AII long.

DESCRIPTION. Shell small, subovoid, gently inflated medially; beaks prominent, near the anterior third-length of the shell, prosogyrous; lunular margin straight; anterior end, slightly produced, rounded; ventral border roundly arched; posterior end roundly truncated; posterior dorsal slope long,

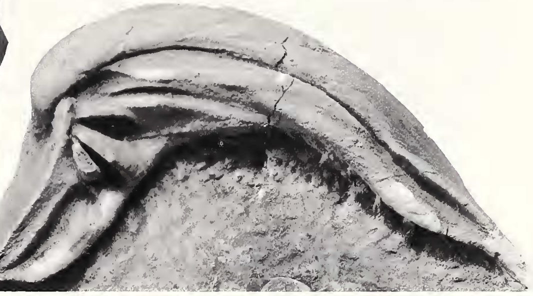
→

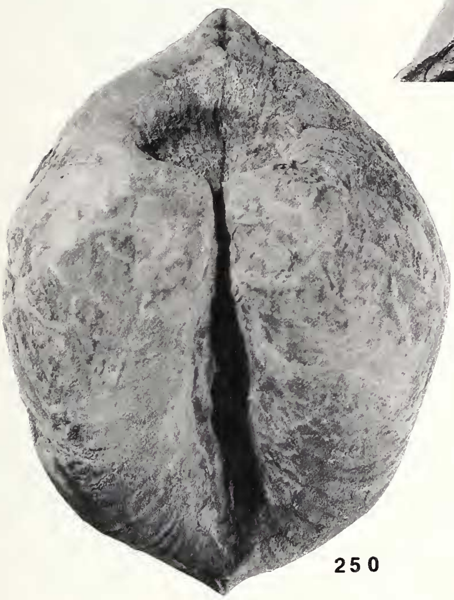
Figures 246–254. *Calva* (*Egelicalva*) *crassa*, new species. All ×1; all specimens whitened with ammonium chloride. **246, 247,** LACMIP cat. no. 8198, paratype, from LACMIP loc. 10695, **246,** exterior, **247,** hinge. **248, 252,** LACMIP cat. no. 8174, paratype, from UCLA loc. 4120, **248,** posterior view, **252,** exterior. **249,** UCLA cat. loc. 40422, paratype, from UCLA loc. 4118, hinge. **250, 251,** LACMIP cat. no. 8177, paratype, from UCLA loc. 4116, **250,** dorsal view, **251,** exterior right valve. **253,** LACMIP cat. no. 8233, paratype, from UCLA loc. 4131, anterior view. **254,** LACMIP cat. no. 8199, paratype, from UCLA loc. 6345, pallial sinus. Photos 246, 247 by Saul; 248, 250–254 by De Leon; 249 by Susuki.

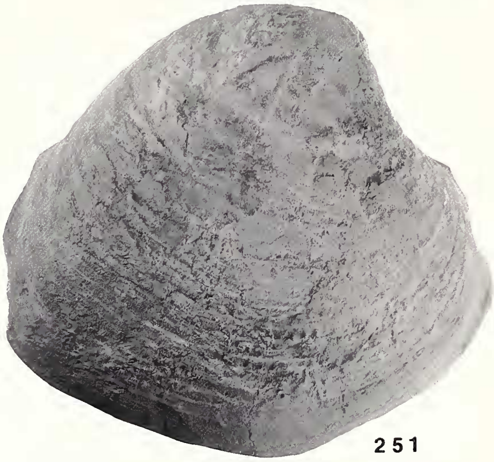

246


247

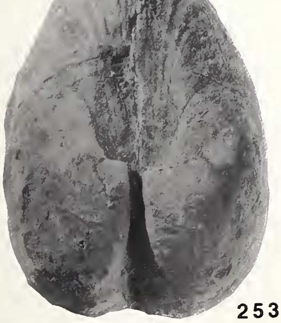
248

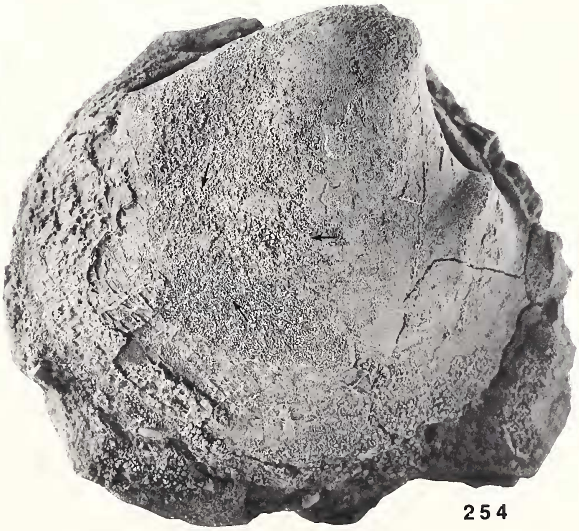

249

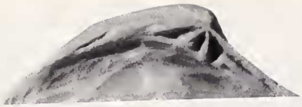

250

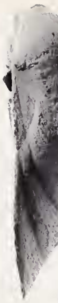

251

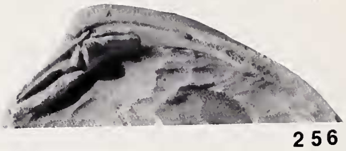
252

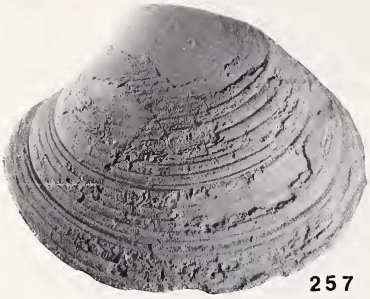

253

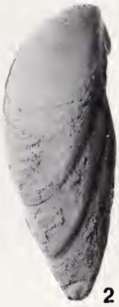

254

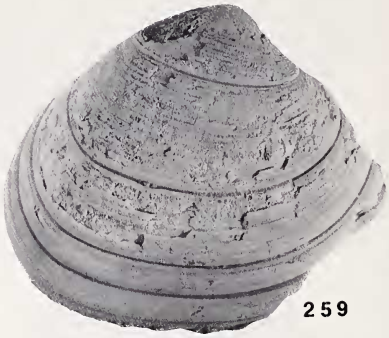

255

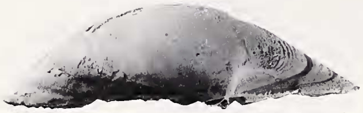

258


256


257


261


259


260

Figures 255–261. *Calva* (*Microcalva*) *elderi,* new species. All ×2; all specimens whitened with ammonium chloride. **255, 257, 258, 260, 261,** USNM cat. no. 456073, holotype, from USGS loc. M8649c, **255,** hinge, **257,** exterior, **258,** anterior view, **260,** dorsal view, **261,** posterior view. **256, 259,** USNM cat. no. 456074, paratype, from USGS loc. M8649b, **256,** hinge, **259,** exterior. All photos by De Leon.

arched; lunule lanceolate, moderately depressed, circumscribed by a line; shell surface ornamented by evenly spaced, flatly round-topped, concentric ribs over-steepened on the dorsal side, and irregularly spaced, impressed growth checks.

Ligament groove moderately long, barely arched behind smooth nymphae. Hinge of right valve with cardinals 3a and 1 divergent, beneath the beak, 1 longer than 3a; cardinal 3b more than twice as long as 1, bifid; anterior laterals elongate enclosing a moderately deep socket for AII, AI rather thick, AIII very slender; posterior lateral PI well developed, bordering an elongate socket. Hinge of left valve with cardinals 2a and 2b sturdy, nearly equal, divergent; cardinal 4b longer, slender, separated from the nymph by a groove; anterior lateral AII moderately long, hooked; posterior lateral PII a barely projecting salient of the valve edge. Pallial sinus unknown.

HOLOTYPE. USNM cat. no. 456073.

PARATYPES. USNM cat. nos. 456074, 456075.

TYPE LOCALITY. USGS loc. M8649c, a clast in conglomerate on north nose of hill 443, elev. 390′ [118.87 m], SW ¼, NE ¼, NW ¼ Sec. 24, T10S, R8E, San Luis Dam Quadrangle, Merced Co., California.

GEOLOGIC AGE. Coniacian, associated with *Meekia louella* Popenoe, 1962.

DISTRIBUTION. Known only from the type locality and vicinity, near San Luis Dam [18], Merced Co., California.

DIMENSIONS. See Table 15.

REMARKS. In outline and inflation *Calva* (*Microcalva*) *elderi* resembles "*Meretrix*" *arata* Gabb, 1864, but "*M.*" *arata* lacks posterior laterals and is sculptured by more closely spaced concentric grooves rather than flatly rounded concentric ribs. *Calva* (*M.*) *elderi* differs from *Calva* (*M.*) *haggarti* in having the anterior end slightly more produced, in being less inflated, and in having the concentric ribs more flattened on their tops and about twice as broad. In C. (*M.*) *elderi* both the anterior laterals and especially cardinal 3b are noticeably longer, and cardinal 2a is more anteriorly directed in C. (*M.*) *haggarti.*

ETYMOLOGY. The species is named for W. P. Elder who collected the type specimens.

Calva (*Microcalva*) *haggarti*, new species

Figures 262–275

Cytherea (*Callista*) *laciniata* Stoliczka, Whiteaves, 1879, p. 148, pl. 17, figs. 13, 13a; pl. 19, figs. 4, 4a. Not *Cytherea* (*Callista*) *laciniata* Stoliczka, 1871.

Cytherea arata (Gabb) Whiteaves, 1895, p. 125. Not *Meretrix arata* Gabb, 1864.

Meretrix arata Gabb Whiteaves, 1903, p. 378. Not *Meretrix arata* Gabb, 1864.

DIAGNOSIS. A plump *Microcalva* with closely spaced, concentric, round-topped ribs.

DESCRIPTION. Shell small, subtrigonal, roundly inflated medially; beaks prominent, at the anterior third-length of the shell, prosogyrous; lunular

Table 15. Measurements of *Calva* (*Microcalva*) *elderi*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
USNM 456073	18.3	23.8	6.8	11.5	5.6	1.6	115°	1.3	3.5	2.1	2.0	3.5
USNM 456074	21.5	26.3	7.8		6.2	1.9	117°	1.2	3.4	—	—	3.3

margin straight; anterior end well rounded; ventral border roundly arched; posterior end roundly truncated; posterior dorsal slope long, arched; lunule plumply lanceolate, moderately depressed, circumscribed by a line; shell surface ornamented by closely, evenly spaced, round-topped, concentric ribs and irregularly spaced, impressed growth checks.

Ligament groove moderately long, barely arched behind smooth nymphae. Hinge of right valve with cardinals 3a and 1 divergent, beneath the beak, 1 longer than 3a; cardinal 3b twice as long as 1, bifid; anterior laterals elongate enclosing a moderately deep socket for AII, AI rather thick, AIII very slender; posterior lateral PI well developed, bordering an elongate socket. Hinge of left valve with cardinals 2a and 2b sturdy, nearly equal, divergent; cardinal 4b longer, slender, scarely separated from the nymph by a shallow groove; anterior lateral AII short, hooked; posterior lateral PII a barely projecting salient of the valve edge. Pallial sinus linguiform, slightly ascending, extending half of the shell length across the valve; dorsal arm a little convex; ventral arm slightly concave, ascending at nearly 40° to the pallial line. Anterior adductor muscle scar impressed, posterior adductor muscle scar not impressed.

HOLOTYPE. LACMIP cat. no. 8242.

PARATYPES. LACMIP cat. nos. 8243–8248 from LACMIP loc. 10446, Sucia Island [3], San Juan Co., Washington.

TYPE LOCALITY. LACMIP loc. 10446, Sucia Island [3], San Juan Co., Washington.

GEOLOGIC AGE. Campanian.

DISTRIBUTION. Northumberland Formation on Hornby Island (Usher, 1952, p. 27); Cedar District Formation of the Nanaimo Basin [1–2], Vancouver Island, British Columbia; Cedar District Formation, Sucia Island [3], San Juan Co., Washington.

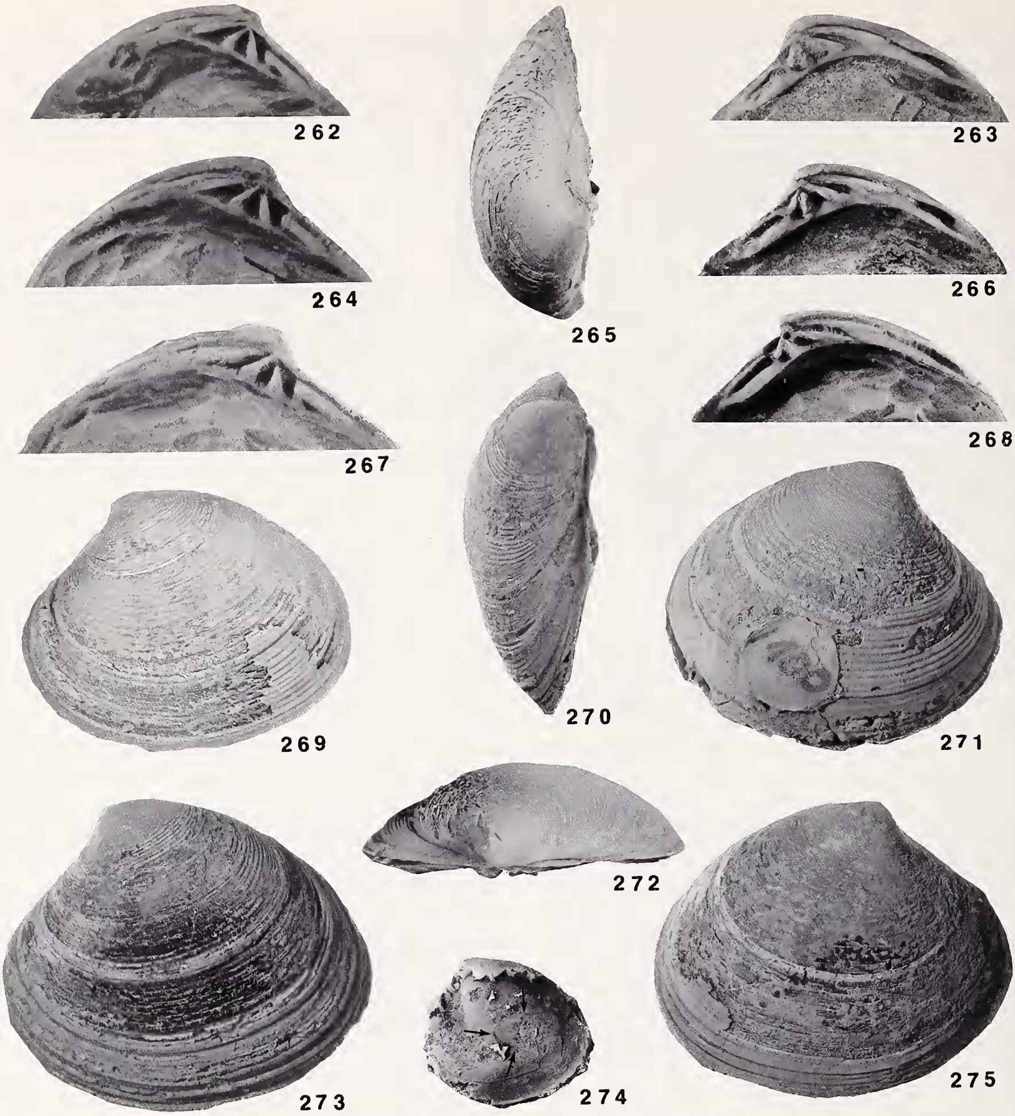
DIMENSIONS. See Table 16.

REMARKS. Whiteaves originally identified this small venerid with the Indian *Cytherea* (*Callista*) *laciniata* Stoliczka (Whiteaves, 1879), but later, in part encouraged by a specimen from Stanton, recognized its similarity to the Californian *?Meretrix arata* Gabb, 1864 (Whiteaves, 1896, 1903). Whiteaves (1903) noted that Gabb's description of the sculpture as inscribed lines did not fit the ribbing of the specimens from Sucia Island [3], but with Stanton's specimen from Tehama County as a guide, he did not differentiate his specimens from *?M. arata* on that basis. In addition to the sculptural differences, *Calva* (*Microcalva*) *haggarti* differs from *Aphrodina? arata* (Gabb, 1864) in being relatively shorter and higher, having more prominent beaks, having finely striate laterals, and having AII posteriorly hooked and parallel to the lunular margin. The specimen Stanton sent to Whiteaves as an example of "*Meretrix*" *arata* may actually have been a *Microcalva,* although we are unacquainted with occurrences of either "*M.*" *arata* or any *Microcalva* in Tehama County. *Calva* (*M.*) *haggarti* differs from *C.* (*M.*) *elderi* in having a shortened anterior, finer, rounder-topped ribs, shorter anterior laterals, and a shorter cardinal 3b. *Calva* (*M.*) *haggarti* differs from immature *C.* (*E.*) *bowersiana* of comparable size from the Cedar District Formation of the Nanaimo Basin in its overall sculpture, greater inflation, and smaller lunule. *Calva* (*M.*) *haggarti* differs from *Loxo decore* Dailey and Popenoe, 1966, in being ribbed rather than having inscribed concentric lines, being more roundly inflated, and having the hooked anterior lateral of *Calva.*

Whiteaves (1879, 1903) recorded this species from the northwest side of Hornby Island and Texada Island, British Columbia [1], and as most abundant from Sucia Island, Washington [3]. Four incomplete specimens (GSC cat. nos. 5716, a–c) identified by him as *Cytherea* (*Caryatis*) *plana* Sowerby [= *Meretrix nitida* Gabb] from the northwest side of

Table 16. Measurements of *Calva* (*Microcalva*) *haggarti*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 8242	18.0	20.9	7.0	10.4	5.5	1.6	109°	1.2	3.0	2.0	1.9	3.4
LACMIP 8243	21.8	27.8	8.4	11.0	6.3	2.0	128°	1.3	3.3	2.5	1.7	3.2
LAMCIP 8244	19.0	22.8	6.0	9.0	6.4	1.8	107°	1.2	3.8	2.5	1.4	3.6
LACMIP 8245	20.2	24.4	8.0	9.6	5.7	2.0	110°	1.2	3.1	2.5	1.7	2.9
LACMIP 8246	19.0	22.6	8.0	10.7	6.4	2.0	112°	1.2	2.8	2.1	1.7	3.2
LACMIP 8247	17.4	21.7	6.0	8.0	6.4	1.6	117°	1.2	3.6	2.7	1.3	4.0



Figures 262–275. *Calva* (*Microcalva*) *haggarti*, new species. All from LACMIP loc. 10446; all specimens whitened with ammonium chloride. **262, 269,** LACMIP cat. no. 8347, paratype, ×2, **262,** hinge, **269,** exterior. **263, 271, 272,** LACMIP cat. no. 8342, holotype, ×2, **263,** hinge, **271,** exterior, **272,** dorsal view. **264, 265, 270, 273,** LACMIP cat. no. 8345, paratype, ×2, **264,** hinge, **265,** anterior view, **270,** posterior view, **273,** exterior. **266,** LACMIP cat. no. 8346, paratype, ×2, hinge. **267,** LACMIP cat. no. 8343, paratype, ×2, hinge. **268, 275,** LACMIP cat. no. 8344, paratype, ×2, **268,** hinge, **275,** exterior. **274,** LACMIP cat. no. 8348, paratype, ×1, pallial sinus. All photos by De Leon.

Hornby Island may be this species. One specimen, GSC 5716a, clearly displays a pallial line like that of *Calva* (*Microcalva*) *haggarti*; another, GSC 5716c, displays the finely striated anterior lateral typical of *Microcalva*. They differ from Sucia Island specimens in having the concentric sculpture only near the beak, confined to the area circumscribed by the first growth check, and in being relatively shorter. The latter two features make these specimens resemble equivalent sized *C.* (*Egelicalva*) *bowersiana*. Determination of whether these specimens should be placed in *C.* (*M.*) *haggarti*, assigned to a new species of *Microcalva*, or recognized as immature *C.* (*E.*) *bowersiana* awaits more complete specimens. Some specimens of *C.* (*M.*) *haggarti* at the Royal British Columbia Museum that were identified by Whiteaves are also labeled as *C. nitida*. Usher (1952, p. 27) lists *Meretrix arata*, Whiteaves' 1903 name for *C.* (*M.*) *haggarti*, from the Lambert Formation (= Northumberland Formation of Muller and Jeletzky, 1970) but does not specify whether from the lower Lambert on Denman Island or the upper Lambert on Hornby Island. Haggart (1989, p. 184) has placed the Northumberland in the *Pachydiscus suciensis* Zone above that of *Metaplacenticeras pacificum*. The range of *C.* (*M.*) *haggarti* cannot be inferred from these old records; it is known with certainly only from Sucia Island where it is of late early Campanian age. Too few specimens of younger age have been available for this study, but those at hand seem to differ sufficiently from the Sucia Island specimens to constitute a different species.

The *Callista* (?) cf. *arata* (Gabb) of Nagao (1932, p. 39, pl. 6, fig. 6, 6a; *Callista ?* sp. Hayami, 1975, p. 145) from the Coniacian–Santonian upper Yezo Group of Hokkaido, Japan, seems to be too inflated to be "*Meretrix*" *arata* Gabb, and its sculpture is described as conforming to Whiteaves' (1903) description of the specimens from Sucia Island. Its hinge is as yet unknown, however, and it cannot be placed in *Microcalva* solely on the basis of its sculpture.

ETYMOLOGY. The species is named for J. M. Haggart, Geological Survey of Canada, in appreciation of his assistance in loaning specimens from the Nanaimo area.

Subgenus *Penecallista,* new subgenus

TYPE SPECIES. *Calva* (*Penecallista*) *marina,* new species.

DIAGNOSIS. Large veneriform *Calva* with a narrow but well-angled escutcheon. Hinge with short 2b, widely bifid 3b, and relatively short anterior laterals. Nymphaea posteriorly salient and having a groove aligned with the posterior socket.

DISCUSSION. This subgenus is proposed with some reluctance, as only the type species may be assigned to it. However, this species displays several characteristics that distinguish it from other subgenera of *Calva.* Its shape is clearly less trigonal and more ovoid than are species of *Egelicalva* or *Calva* s.s. The combination of relatively short cardinal tooth 2b, widely bifid 3b, and relatively short anterior laterals makes the hinge look less like that of *Calva* s.s. and *Egelicalva* than does the hinge of the much smaller *Microcalva.* In addition, the well-marked groove aligned with the posterior lateral socket on the posterior end of the nymph is not as evident on any other *Calva.*

The shell shape is similar to that of Recent species of *Callista* (*Megapitaria*) Grant and Gale, 1931, from the Panamic faunal province, the hinge plate is of similar width, and the anterior laterals are of similar length. However, *Callista* (*Megapitaria*) lacks posterior laterals, its anterior laterals are at an angle to the valve margin, and anterior lateral AII is not hooked as in *Calva.* In *Callista* (*Megapitaria*), the margin of the right valve is grooved posterior to the ligament to hold a corresponding tongue of the left valve margin. These tongue and groove structures are probably not homologous to the posterior laterals of *Calva,* as the tongue and groove are dorsal to the end of the ligament groove with which the posterior laterals of *Calva* are aligned.

ETYMOLOGY. The subgeneric name is compounded from *pene,* Latin, near, and the venerid genus name *Callista.*

Calva (*Penecallista*) *marina,* new species

Figures 276–287

Flaventia zeta Popenoe, Sundberg, 1979, p. 176, pl. 1, fig. 8. Not *Flaventia zeta* Popenoe, 1937.

DIAGNOSIS. As for the subgenus.

DESCRIPTION. Shell large, nearly as high as long, moderately inflated, rather thick; beaks prominent, placed anterior to the mid-length of the shell, prosogyrous; anterior dorsal border concave; anterior end rounded; ventral border broadly arched; posterior end truncate vertically; posterior dorsal border arched; lunule relatively small, deep, delimited by an inscribed line; escutcheon narrow, defined by rounded angulation; posterior slope demarked by subangulate change in slope.

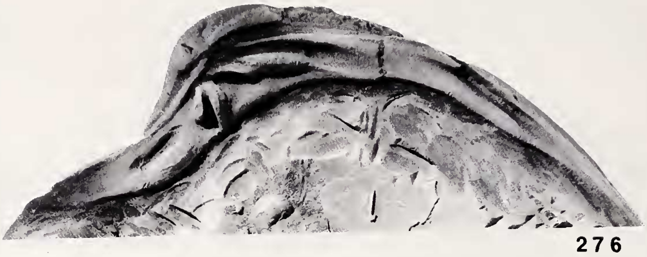
Ligament groove long, arched behind strong, posteriorly projecting nymphs. Hinge of right valve with anterior tooth 3a short; 3a and median cardinal tooth 1 narrow, prominent, close together, slightly divergent ventrally, situated directly beneath the beaks; 3a longer than 1, extending from about the hinge plate edge as close to the beak as 3a; right posterior cardinal 3b long, arched, bifid, dorsal arm much the longer, subparallel to nymph; socket for lateral AII moderately elongate, about as long as cardinal 1, narrow, moderately deep, smooth; socket for PII long, deep, bounded below by an elongate tooth. Hinge of left valve with anterior cardinal 2a prominent, slender, gently curved, slightly posteriorly directed; cardinal 2b short, broad based, trigonal, sloping upward to high dorsal side, posteriorly directed; posterior cardinal 4b elongate, twice as long as the anterior teeth, slender; anterior lateral AII elongate, barely longer than cardinal 2b, posteriorly hooked, long arm parallel to lunular

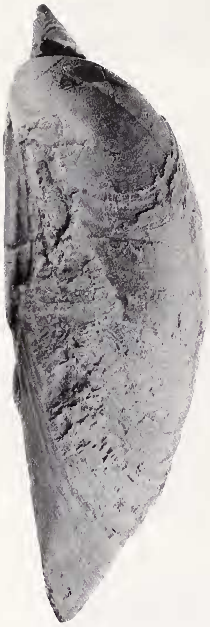
---

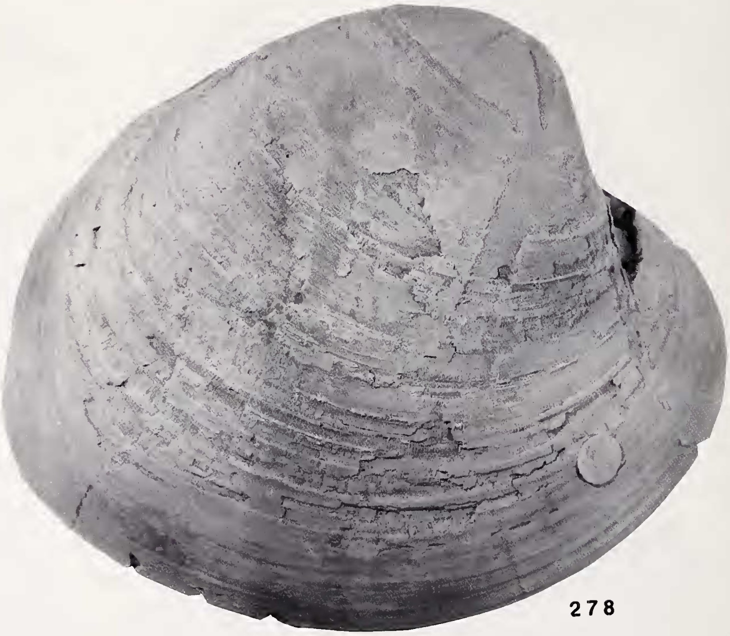
⟶

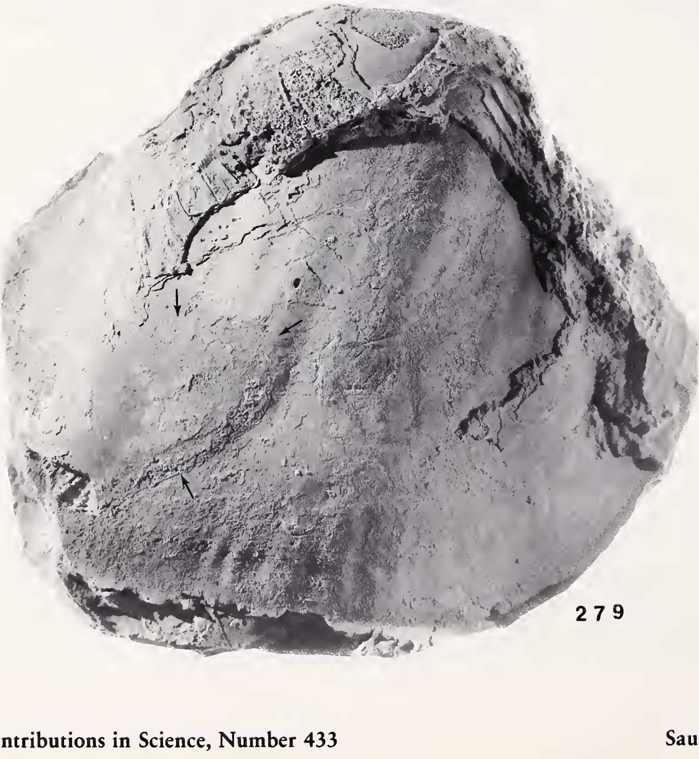
Figures 276–280. *Calva* (*Penecallista*) *marina,* new species. All ×1; all specimens whitened with ammonium chloride. **276–278,** LACMIP cat. no. 8249, holotype, from UCLA loc. 3796, **276,** hinge, **277,** posterior view, **278,** exterior. **279,** LACMIP cat. no. 8253, paratype, from UCLA loc. 4863, pallial sinus. **280,** LACMIP cat. no. 8252, paratype, from UCLA loc. 4863, dorsal view. All photos by De Leon.

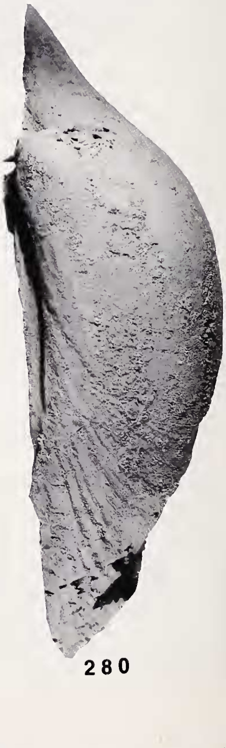
Figures 281–287. *Calva* (*Penecallista*) *marina,* new species. All ×1; all specimens whitened with ammonium chloride. **281,** LACMIP cat. no. 8250, paratype, from UCLA loc. 4863, hinge. **282, 287,** LACMIP cat. no. 8252, paratype, from UCLA loc. 4863, **282,** anterior view, **287,** hinge. **283, 285,** USNM cat. no. 456071, paratype, from USGS loc. M4017, **283,** hinge, and exterior of *Loxo decore* Dailey and Popenoe, 1966, **285,** exterior. **284, 286,** LACMIP cat. no. 8251, paratype, from UCLA loc. 4863, **284,** exterior, **286,** posterior view. All photos by De Leon.

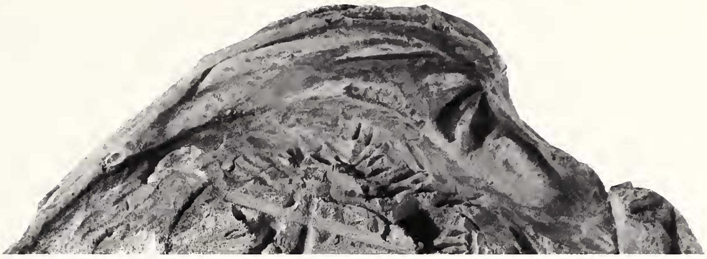

276


277

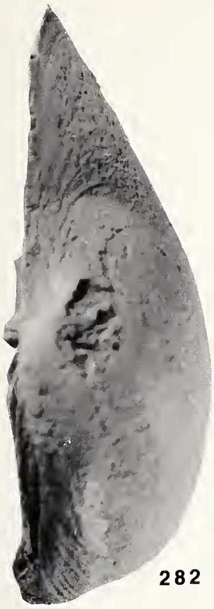

278


279

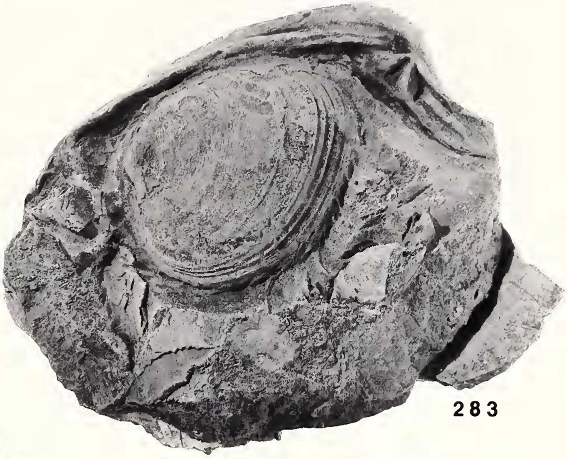

280



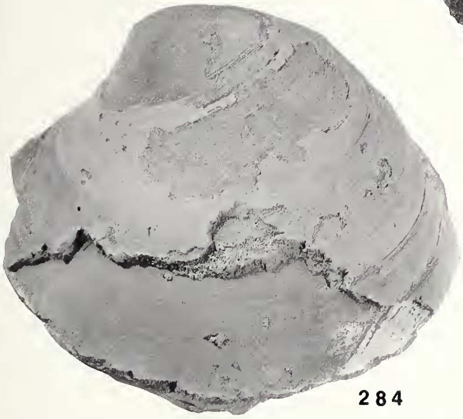
281



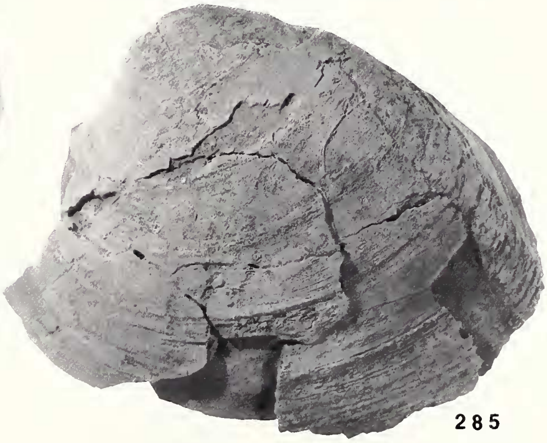
282



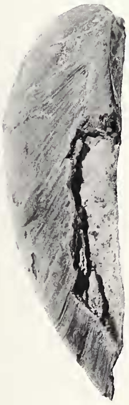
283



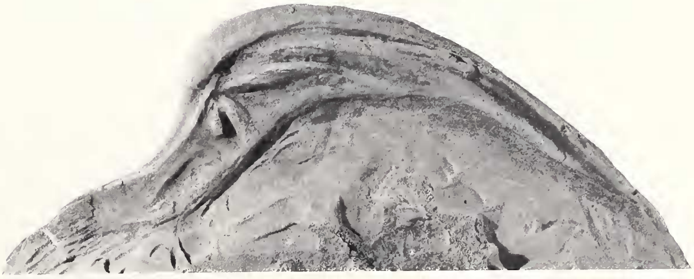
284



285



286



287

Table 17. Measurements of *Calva* (*Penecallista*) *marina*. Dimensional abbreviations defined in Figure 4.

	H (mm)	L (mm)	I (mm)	B (mm)	LL (mm)	LW (mm)	LTA	L/H	L/I	L/B	B/LL	LL/ LW
LACMIP 8249	79.0	92.4	25.4	34.8	16.3	4.2	100°	1.2	3.6	2.7	2.1	3.9
LACMIP 8250	90.9	108.0	32	35.5	15.3	4.8	98°	1.2	3.4	3.0	2.3	3.2
LACMIP 8251	53.7	63.0	17.8	24.0	11.5	2.7		1.2	3.5	2.6	2.1	4.3
LACMIP 8252	85.0	108.0	26.7	35.4	15.5	4.8	104°	1.3	5.0	3.0	2.3	3.2

margin, smooth sided; posterior lateral tooth PII, a slightly salient portion of the shell-margin just posterior to the rear end of the nymph. Pallial sinus U-shaped, ascending, extending across one-third of the shell length.

HOLOTYPE. LACMIP cat. no. 8249.

PARATYPES. USNM cat. no. 456071 from USGS loc. M4017, Sisquoc River [22], Santa Barbara Co., California; LACMIP cat. nos. 8250–8253 from UCLA loc. 4863, San Antonio del Mar [30], Baja California, Mexico.

HYPOTYPE. LACMIP cat. no. 7745 (hypotype of *Flaventia zeta* Popenoe of Sundberg, 1979) from LACMIP loc. 11629, La Jolla [28], San Diego Co., California.

TYPE LOCALITY. UCLA loc. 3796, San Antonio del Mar [30], Baja California, Mexico.

GEOLOGIC AGE. ?Latest Campanian and early Maastrichtian.

DISTRIBUTION. Unnamed formation along the Sisquoc River [22], Hurricane Deck Quadrangle, Santa Barbara Co.; Williams Formation along Bee Canyon [26], Orange Co.; ?basal Point Loma Formation at La Jolla [28], San Diego Co., California. Rosario Formation, near San Antonio del Mar [30], Baja California, Mexico.

DIMENSIONS. See Table 17.

REMARKS. The left valve figured as *Flaventia zeta* by Sundberg (1979) was prepared by sawing parallel to the plane of commissure; the saw blade removed most of the hinge teeth. Part of the inscribed lunule yet remains. Bases of some of the hinge teeth and the shape of the hinge plate are also visible. The widening of the hinge plate adjacent to the lunule indicates that an anterior lateral tooth was present; *Flaventia* lacks laterals and does not have an inscribed lunule. The growth line of this specimen and its degree of inflation are most similar to that of *Calva* (*Penecallista*) *marina*. As in C. (*P.*) *marina* cardinal tooth 2b is short, extending about halfway across the hinge plate. This specimen is from the basal Point Loma sandstone and from below the early Maastrichtian magnetic reversal 32r (Bannon et al., 1989). It may, therefore, be of late Campanian age.

In addition to several specimens of *Calva* (*Penecallista*) *marina,* USGS loc. M4017 has yielded *Crassatella* (?) *elongata* Anderson, 1958, *Crassatella* (?) *saulae* Dailey and Popenoe, 1966, and *Loxo decore* Dailey and Popenoe, 1966. *Crassatella* (?) *elongata* has previously been found in the late Campanian *Metaplacenticeras pacificum* Zone but not the succeeding *Pachydiscus* (*Neodesmoceras*) *catarinae* Zone; C. (?) *saulae* has been recovered from late in the *M. pacificum* Zone and the *P.* (*N.*) *catarinae* Zone, and *Loxo decore* is from the *M. pacificum* Zone and the *P.* (*N.*) *catarinae* Zone. The Sisquoc River [22] specimens are, therefore, probably of very late Campanian age. The sequence at Bee Canyon [26], Orange Co., also yields several late Campanian indicators, among which are *Metaplacenticeras pacificum* and *Perissitys pacificum* Popenoe and Saul, 1987. At its type locality north of San Antonio del Mar, *Calva* (*Penecallista*) *marina* occurs both stratigraphically below and above occurrences of C. (*C.*) *peninsularis* and is associated with *Perissitys colocara* Popenoe and Saul, 1987, and *Murphitys madona* Popenoe and Saul, 1987, both of which are considered to be of early Maastrichtian age.

Calva (*Penecallista*) *marina* is a large species comparable in size to C. (*Egelicalva*) *crassa,* but C. (*P.*) *marina* is more elongate and less inflated than C. (*E.*) *crassa.* In shape C. (*P.*) *marina* is more like C. (*C.*) *peninsularis,* but its posterior angulation is closer to the posterior margin. *Calva* (*P.*) *marina* has a cardinal 3b that is more bent and nymphs that are more strongly projecting posteriorly than any other species herein assigned to *Calva.* It differs from all other *Calva* in the shortness of 2b and in having the posterior end of the nymph noticeably grooved.

In shape *Calva* (*Penecallista*) *marina* resembles the Recent *Callista* (*Megapitaria*) *aurantiaca* (Sowerby, 1831), and *Callista* (*Megapitaria*) *squalida* (Sowerby, 1835), from the Panamic faunal province, and is roughly the same size. These two may be the largest Recent pitarine venerids; C. (*M.*) *aurantiaca* is slightly the larger but has a somewhat shorter geographic range and lives from just subtidally to a depth of about 10 m, but C. (*M.*) *squalida* inhabits sandy mud flats and has been found offshore down to 160 m (Keen and McLean, 1971, p. 176). *Calva* (*Penecallista*) *marina* may have had a subtidal but shallow water habitat, and as it has not been found north of Santa Barbara County, it may have been a thermophilic species. Its size suggests that by the Late Cretaceous some pitarine venerids had already achieved the upper size range of the group.

ETYMOLOGY. The specific name is from Latin, *marinus,* of the sea, for San Antonio del Mar.

ACKNOWLEDGMENTS

Popenoe pursued species of *Calva* for nearly 50 years. During this time monies of the Penrose Fund, UCLA Academic Senate Research grants, and a National Science Foundation Research Grant were, in part, used to disentangle the species of this genus. Specimens were loaned by the late J. H. Peck, J. W. Durham, and D. R. Lindberg of the University of California, Berkeley, Museum of Paleontology; the late L. G. Hertlein and P. U. Rodda of the California Academy of Sciences; D. L. Jones and W. P. Elder of the U.S. Geological Survey, Menlo Park, California; the late H. G. Richards of the Academy of Natural Sciences of Philadelphia; J. M. Haggart, Geological Survey of Canada; and Richard Hebda and Richard Kools of the Royal British Columbia Museum. We especially thank D. R. Lindberg for his efforts to reorganize and identify specimens collected by the California Geological Survey (Whitney Survey) and deposited in the University of California, Berkeley, Museum of Paleontology.

Major collections were made by D. H. Dailey from the Jalama Formation, Santa Barbara Co., California; M. A. Murphy and P. U. Rodda from the Budden Canyon Formation, Shasta Co., California; and G. P. Zebal from the Chatsworth Formation on the east end of the Simi Hills, Ventura and Los Angeles Cos., California. Additional important specimens were supplied by Robert Demetrion, J. M. Alderson, and D. P. Smith.

This paper has been read critically by G. L. Kennedy, E. C. Wilson, E. J. Moore, and W. P. Elder. We are grateful for their suggestions; any errors are the responsibility of L. R. Saul. The line drawings for Figures 2–5 were drafted by W. Smith-Griswold. This paper had a long gestation, and the photographs were produced over a 30-year period by T. Susuki (UCLA), L. R. Saul, and J. De Leon (LACMNH).

LITERATURE CITED

Adams, H., and A. Adams. 1853–1858. *The genera of Recent Mollusca arranged according to their organization.* London: John Van Vorst, 1:vi–xl, 1–484; 2:1–661; 3, pls. 1–138. [Dating of parts, 2:661.]

Anderson, F.M. 1902. Cretaceous deposits of the Pacific Coast. *California Academy of Sciences, Proceedings, Series 3* 2:1–154, pls. 1–12.

———. 1938. Lower Cretaceous deposits in California and Oregon. *Geological Society of America, Special Papers* 16:1–339, 84 pls.

———. 1958. Lower Cretaceous of the Pacific Coast. *Geological Society of America, Memoir* 71:1–378, 75 pls.

Anderson, F.M., and G.D. Hanna. 1935. Cretaceous geology of Lower California. *California Academy of Sciences, Proceedings, Series 4* 23(1):1–34, pls. 1–11, 2 text figs.

Arnold, R. 1908. Descriptions of new Cretaceous and Tertiary fossils from the Santa Cruz Mountains, California. *United States National Museum, Proceedings* 34(1617):345–390, pls. 31–37.

Bannon, J.L., D.J. Bottjer, S.P. Lund, and L.R. Saul. 1989. Campanian/Maastrichtian stage boundary in southern California: Resolution and implications for large-scale depositional patterns. *Geology* 17:80–83.

Brown, R.D., Jr., and E.I. Rich. 1960. Early Cretaceous fossils in submarine slump deposits of Late Cretaceous age, northern Sacramento Valley, California. *United States Geological Survey Professional Paper* 400-B:B318–B320.

Casey, R. 1952. Some genera and subgenera, mainly new, of Mesozoic heterodont lamellibranchs. *Malacological Society of London* 29:121–176, pls. 7–9, 100 text figs.

Champion, D.E., C.S. Grommé, and D.G. Howell. 1981. Paleomagnetic study of the Upper Cretaceous Pigeon Point Formation. In *Upper Cretaceous and Paleocene turbidites, central California coast, Book 20,* ed. V. Frizzell, 53–70. Society of Economic Paleontologists and Mineralogists, Pacific Section.

Clark, B.L., and A.O. Woodford. 1927. The geology and paleontology of the type section of the Meganos Formation (lower middle Eocene of California). *University of California Publications, Department of Geological Sciences, Bulletin* 17:63–142, pls. 14–22, 1 map.

Coan, E.V. 1981. *James Graham Cooper, pioneer western naturalist.* Moscow, Idaho: University Press of Idaho, 255 pp.

Colburn, I.P. 1964. *The Mesozoic stratigraphy in the vicinity of Mount Diablo, California.* Geological Society of Sacramento Guide Book and Field Trip, Mount Diablo Area, pp. 9–22, chart.

Conrad, T.A. 1857. Descriptions of Cretaceous and Tertiary fossils. V. 1, pt. 2, pp. 141–174, pls. 1–21. In *Report on the United States and Mexican boundary survey,* ed. W.H. Emory. United States 34th Congress, 1st Session, Senate Executive Document 108, v. 20 and House Executive Document 135, v. 14.

———. 1864. Notes on shells, with descriptions of new fossil genera and species. *Academy of Natural Sciences of Philadelphia, Proceedings* 16:211–214, figs.

———. 1869. Notes on Recent and fossil shells, with descriptions of new genera. *American Journal of Conchology* 4:246–249, pl. 18, fig. 5.

Cooper, J.G. 1894. Catalogue of Californian fossils (Pt. 2–5). *California State Mining Bureau Bulletin* 4:1–65, 6 pls.

Crandall, R. 1907. The Cretaceous stratigraphy of the Santa Clara Valley region in California. *American Journal of Science* 24:33–54, 3 text figs.

Dailey, D.H., and W.P. Popenoe. 1966. Mollusca from the Upper Cretaceous Jalama Formation, Santa Barbara County, California. *University of California Publications in Geological Sciences* 65:1–41, 6 pls., 3 text figs.

Dickerson, R.E. 1914. Fauna of the Martinez Eocene of California. *University of California Publications, Department of Geology, Bulletin* 8:61–108, pls. 6–18.

Forbes, E. 1846. Report on the Cretaceous fossil invertebrates from southern India, collected by Mr. Kaye and Mr. Cunliffe. *Geological Society of London, Transactions [1845], Series 2* 7:97–174, pls. 7–19.

Fry, J.G., D.J. Bottjer, and S.P. Lund. 1985. Magnetostratigraphy of displaced Upper Cretaceous strata in southern California. *Geology* 13:648–651, 3 figs.

Gabb, W.M. 1864. Description of the Cretaceous fossils. *California Geological Survey, Palæontology* 1: 57–243 [1864], pls. 9–32 [1865].

———. 1866–1869. Cretaceous and Tertiary fossils. *California Geological Survey, Palæontology* 2:1–299, 36 pls.

Grant, U.S., IV, and H.R. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions. *San Diego Society of Natural History Memoirs* 1:1–1036, pls. 1–32, 15 figs.

Haggart, J.W. 1989. New and revised ammonites from the Upper Cretaceous Nanaimo Group of British Columbia and Washington State. *Contributions to Canadian Paleontology, Geological Survey of Canada, Bulletin* 396:181–221, pls. 8.1–8.6, text figs. 8.1–8.7.

Hall, C.A., Jr. 1958. Geology and paleontology of the Pleasanton area, Alameda and Contra Costa Counties, California. *University of California Publications in Geological Sciences* 34:1–90, pls. 1–12, 2 figs., 5 maps.

Hayami, I. 1975. A systematic survey of the Mesozoic Bivalvia from Japan. *University of Tokyo, University Museum Bulletin* 10:1–249, 10 pls.

Hector, J. 1861. On the geology of the country between Lake Superior and the Pacific Ocean (between the 48th and 54th parallels of latitude), visited by the Government Exploring Expedition under the command of Captain J. Palliser. *Geological Society of London Quarterly Journal* 17:388–445.

Ichikawa, K., and Y. Maeda. 1963. Late Cretaceous pelecypods from the Izumi Group. Part III. Order Heterodontida (1). *Osaka City University Journal of Geosciences* 7:113–144, pls. 8–11.

Jones, D.L. 1963. Upper Cretaceous (Campanian and Maastrichtian) ammonites from southern Alaska. *United States Geological Survey Professional Paper* 432:i–iv, 1–53, 41 pls., 25 text figs., 2 tables.

Jones, D.L., W.V. Sliter, and W.P. Popenoe. 1978. Mid-Cretaceous (Albian to Turonian) biostratigraphy of northern California. *Muséum d'Histoire Naturelle de Nice, Annales* 4[1976]:XXII.1–XXII.13, 2 pls., 7 figs., 1 table.

Jukes-Brown, A.J. 1908. On the genera of Veneridae represented in the Cretaceous and older Tertiary deposits. *Malacological Society of London, Proceedings* 8:148–177, pl. 6.

Keen, A.M., and J.H. McLean. 1971. *Sea shells of tropical West America.* 2nd ed. Stanford, California: Stanford University Press, 1064 pp., 22 pls., text figs.

Klinger, H.C., and W.J. Kennedy. 1980. The Umzamba Formation at its type section, Umzamba Estuary (Pondoland, Transkei), the ammonite content and paleogeographical distribution. *South African Museum, Annals* 81:207–222, 5 figs.

Matsumoto, T. 1959. Upper Cretaceous ammonites of California. Part II. *Kyushu University, Faculty of Science, Memoirs, Series D, Geology, Special Volume* 1:1–172, 41 pls., 80 text figs.

———. 1960. Upper Cretaceous ammonites of California. Part III. *Kyushu University, Faculty of Science, Memoirs, Series D, Geology, Special Volume* 2:1–204, 2 pls., 20 text figs.

Meek, F.B. 1857. Descriptions of new organic remains from the Cretaceous rocks of Vancouver's Island. *Albany Institute, Transactions* 4:37–49 [1858].

———. 1862. Descriptions of new Cretaceous fossils collected by the North-Western Boundary Commission, on Vancouver and Sucia Islands. *Academy of Natural Sciences of Philadelphia, Proceedings* 13: 314–318.

Meek, F.B., and F.V. Hayden. 1856. Descriptions of twenty-eight new species of Acephala and one gastropod from the Cretaceous formations of Nebraska Territory. *Academy of Natural Sciences of Philadelphia, Proceedings* 8:81–87.

Merriam, J.C. 1895. A list of type specimens in the Geological Museum of the University of California, which have served as originals for the figures and descriptions in the Paleontology of the State Geological Survey of California under J.D. Whitney. Compiled for the use of workers in California geology, Geology Department, University of California, Berkeley, July 1. [This paper contains 3 printed pages which are not numbered.] Reprinted by A.W. Vogdes, 1896. *California Mining Bureau Bulletin* 10:21–23; 2nd edition, 1904, *Bulletin* 30:39–42.

———. 1897. The geologic relations of the Martinez Group of California at the typical locality. *Journal of Geology* 5:767–775.

Michael, R. 1899. Ueber Kreidefossilien von der Insel Sachalin. *Königlich Preussischen geologischen Landesanstalt und Berkakademie zu Berlin* 19:153–164, pls. 5–6.

Moore, E.J. 1968. Fossil mollusks of San Diego County. *San Diego Society of Natural History, Occasional Paper* 15:1–76, 34 pls.

Moore, R.C. [ed.]. 1969. *Treatise on invertebrate paleontology. Pt. N. Mollusca 6, Bivalvia 1–2.* Lawrence, Kansas: Kansas University Press and Geological Society of America, 952 pp., figs. 1–103, A1–12, B1–5, C1–107, D1–76, E1–176, F1–32, G1, H1–2.

Muller, J.E., and J.A. Jeletzky. 1970. Geology of the Upper Cretaceous Nanaimo Group, Vancouver Island, and Gulf Islands, British Columbia. *Canada Geological Survey Paper* 69-25:i–vi, 1–77, 11 figs., 3 tables.

Murphy, M.A., and P.U. Rodda. 1960. Mollusca of the Cretaceous Bald Hills Formation of California. *Journal of Paleontology* 34:835–858, pls. 101–107, 2 text figs.

Nagao, T. 1932. Some Cretaceous Mollusca from Japanese Saghalin and Hokkaido (Lamellibranchiata and Gastropoda). *Hokkaido Imperial University, Faculty of Science, Journal Series 4, Geology and Mineralogy* 2:23–50, pls. 5–8.

Nagao, T., and K.I. Otatume. 1963. Molluscan fossils of Hakobuti Sandstone of Hokkaidô. *Hokkaido Imperial University, Faculty of Science, Journal Series IV, Geology and Mineralogy* 4:32–56, pls. 1–4, text fig. 1.

Packard, E.L. 1922. New species from the Cretaceous of the Santa Ana Mountains, California. *University of California Publications, Department of Geological Sciences, Bulletin* 13:413–462, pls. 24–38.

Palmer, A.R. 1983. Decade of North American Geology (DNAG). Geologic time scale. *Geology* 11:503–504.

Poli, J.X. 1791–1827. *Testacea utruisque Siliciae eorumque historia et anatomie tabulis aeneis illustrata.* [In Latin, with Italian and French plate explanations.] Parma, Italy. V. 1 (1791), [6] + x + 90 + 51 + lxxiii pp., frontispiece, pls. 1–18; V. 2 (1795), [4] + 246 + lxvi pp., pls. 19–39; V. 3, pt. 1 (1826) [issued posthumously by S. Delle Chiaje], [6] + xxiv + 44 + xlviii pp., pls. 40–49; V. 3, pt. 2 (1827) [by S. Delle Chiaje], 56 pp., pls. 50–57.

Popenoe, W.P. 1937. Upper Cretaceous Mollusca from Southern California. *Journal of Paleontology* 11:379–402, pls. 45–49.

———. 1940. California Cretaceous mollusks, correction. *Journal of Paleontology* 14:163.

———. 1942. Upper Cretaceous formations and faunas of Southern California. *American Association of Petroleum Geologists, Bulletin* 26:162–187, 4 text figs.

———. 1943. Cretaceous: East side Sacramento Valley, Shasta and Butte Counties, California. *American Association of Petroleum Geologists, Bulletin* 27:306–312.

———. 1954. Mesozoic formations and faunas, southern California and northern Baja California. *California Division of Mines, Bulletin, Historical Geology* 170(Chapter III):15–21, figs. 1–4.

———. 1964. *Calva,* Cretaceous venerid pelecypod genus. *Geological Society of America Special Paper* 76:219.

———. 1973. Southern California Cretaceous formations and faunas with especial reference to the Simi Hills and Santa Monica Mountains. In *Cretaceous stratigraphy of the Santa Monica Mountains and Simi Hills, Southern California. Geological guidebook, 1973 fall field trip,* ed. A.E. Fritsche, 15–29, 4 pls., 2 text figs. Society of Economic Paleontologists and Mineralogists, Pacific Section.

———. 1983. Cretaceous Aporrhaidae from California: Aporrhainae and Arrhoginae. *Journal of Paleontology* 57:742–765, 6 figs.

Popenoe, W.P., and L.R. Saul. 1987. Evolution and classification of the Late Cretaceous–early Tertiary gastropod *Perissitys. Contributions in Science* 380: 1–37, 182 figs.

Popenoe, W.P., L.R. Saul, and T. Susuki. 1987. Gyrodiform gastropods from the Pacific Coast Cretaceous and Paleocene. *Journal of Paleontology* 61: 70–100, 7 figs.

Rennie, J.V.L. 1930. New Lamellibranchia and Gastropoda from the Upper Cretaceous of Pondoland. *South African Museum, Annals* 28:159–260, pls. 16–31, 3 text figs.

Rodda, P.U. 1959. *Geology and paleontology of a portion of Shasta County, California.* Dissertation, University of California, Los Angeles, 205 pp., 20 pls.

Saul, L.R. 1970. Upper Cretaceous faunas of Punta Banda. In *Pacific Slope geology of northern Baja California and adjacent Alta California. Guidebook, 1970 fall field trip,* ed. E.C. Allison, M.G. Acosta, D.L. Fife, J.A. Minch, and K. Nishikawa, 79–82, figs. 1–22. American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, and Society of Exploration Geophysicists, Pacific Sections.

———. 1974. Described or figured West Coast species of *Cymbophora. Journal of Paleontology* 48:1068–1095, 3 pls., 7 text figs.

———. 1978. The North Pacific Cretaceous trigoniid genus *Yaadia. University of California Publications, Geological Sciences* 119:1–65, 12 pls., 20 text figs., 12 tables.

———. 1983. *Turritella* zonation across the Cretaceous–Tertiary boundary, California. *University of California Publications, Geological Sciences* 125:1–164, 7 pls., 27 text figs.

———. 1986. Mollusks of latest Cretaceous and Paleocene age, Lake Nacimiento, California. In *Geology of Upper Cretaceous and Lower Tertiary rocks near Lake Nacimiento, California. Geological guidebook, 1986 fall field trip, Book 49,* ed. K. Grove and S.A. Graham, 25–32, 60 figs. Society of Economic Paleontologists & Mineralogists, Pacific Section.

———. 1988. California Late Cretaceous donaciform bivalves. *Western Society of Malacologists* 20:33–34.

———. In press. Pacific Slope Cretaceous bivalves: eight venerid species. *Journal of Paleontology.*

Saul, L.R., and J.M. Alderson. 1981. Late Cretaceous Mollusca of the Simi Hills: An introduction. In *Simi Hills Cretaceous turbidites, southern California. Fall 1981 field trip, volume and guidebook,* ed. M.H. Link, R.L. Squires, and I.P. Colburn, 29–41, 3 pls., 1 fig. Society of Economic Paleontologists & Mineralogists, Pacific Section.

Saul, L.R., and W.P. Popenoe. 1962. *Meekia,* enigmatic Cretaceous pelecypod genus. *University of California Publications in Geological Sciences* 40:289–344, 6 pls.

Sliter, W.V. 1968. Upper Cretaceous foraminifera from Southern California and Northwestern Baja California, Mexico. *University of Kansas, Paleontology Contributions, Protozoa* 49(7):1–141, 24 pls., 9 figs., 15 tables.

Smith, J.P. 1900. The development and phylogeny of *Placenticeras. California Academy of Sciences, Proceedings, Series 3* 1:181–240, pls. 24–28.

Sowerby, G.B. 1821–1834. *The genera of Recent and fossil shells.* London. V. 1, pl. 1–126 and text (pages unnumbered) 1821–1825; V. 2, pls. 127–262 (pages unnumbered) (1825?–1834). Plates by J. Sowerby and J. de C. Sowerby.

Sowerby, J. 1812. The mineral conchology of Great Britain, or coloured figures and descriptions of those remains of testaceous animals. London. V. 1, 250 p., 102 pls.

Sowerby, J. de C. 1836. Appendix A. Descriptive notes respecting the shells figured in Plates XI–XXIII. In *Observations on some strata between the Chalk and the Oxford Oolite in the Southeast of England. Geological Society of London, Transactions, Series 2,* V. 4, ed. W.H. Fitton, 335–348, pls. 11–23.

Speden, I.G. 1970. The type Fox Hills Formation, Cretaceous (Maestrichtian), South Dakota. Part 2. Systematics of the Bivalvia. *Yale University, Peabody Museum of Natural History, Bulletin* 33:1–222, 42 pls., 19 text figs.

Stadum, C.J. 1973. *A student guide to Orange County fossils.* Orange, California: Chapman College Press, 64 p., 7 pls.

Stewart, R.B. 1927. Gabb's California fossil type gastropods. *Academy of Natural Sciences of Philadelphia, Proceedings* 78(1926):287–447, pls. 20–32.

——— 1930. Gabb's California Cretaceous and Tertiary type lamellibranchs. *Academy of Natural Sciences, Philadelphia, Special Publication* 3:1–314, 17 pls.

Stoliczka, F. 1871. Cretaceous fauna of Southern India. The Pelecypoda. *Geological Survey of India, Memoirs, Palaeontologia Indica, Series 6* 3:1–537, 50 pls.

Sundberg, F.A. 1979. Upper Cretaceous macro-fossils of San Diego. In *Geological excursions in the Southern California area,* ed. P.L. Abbott, 173–176, 1 pl., 2 text figs., 2 tables. San Diego, California: Department of Geological Sciences, San Diego State University for Geological Society of America Annual Meeting, Nov., 1979.

Sundberg, F.A., and B.O. Riney. 1984. Preliminary report on the Upper Cretaceous macro-invertebrate fauna near Carlsbad, California. In *Upper Cretaceous depositional systems Southern California–Northern Baja California. Volume and guidebook 36,* ed. P.L. Abbott, 103–107, 3 figs. San Diego, California: Society of Economic Paleontologists and Mineralogists, Pacific Section, annual meeting.

Taff, H.A., G.D. Hanna, and C.M. Cross. 1940. Type locality of the Cretaceous Chico Formation. *Geological Society of America, Bulletin* 51:1311–1328, 2 pls., 1 fig.

Taliaferro, N.L. 1944. Cretaceous and Paleocene of Santa Lucia Range, California. *American Association of Petroleum Geologists, Bulletin* 28:449–521, 18 text figs.

Trask, J.B. 1856. Description of a new species of ammonite and baculite from the Tertiary rocks of Chico Creek. *California Academy of Sciences, Proceedings* 1:89, 92–93, pl. 2. [Reprint of 1873—this was originally published in a San Francisco newspaper, "The Pacific"—no changes made in text. P. 89 (originally 83) is the reference to Dr. Randall's specimens of Tertiary fossils from Chico Creek, under the title "Donations to the Cabinet." P. 92 (originally p. 85) has article title and original p. 86 begins part way thru *Baculites chicoensis* description on p. 93.]

Trueman, E.R., A.R. Brand, and P. Davis. 1966. The effect of substrate and shell shape on the burrowing of some common bivalves. *Malacological Society of London, Proceedings* 37:97–109, text figs. 1–8.

Usher, J.L. 1952. Ammonite faunas of the Upper Cretaceous rocks of Vancouver Island, British Columbia. *Canada Geological Survey Bulletin* 21:1–182, 31 pls., 3 text figs.

Vokes, H.E. 1939. Molluscan faunas of the Domengine and Arroyo Hondo Formations of the California Eocene. *New York Academy of Sciences, Annals* 38:1–246, pls. 1–22.

Ward, P.D. 1978. Revision of the stratigraphy and bichronology of the Upper Cretaceous Nanaimo Group, British Columbia and Washington State. *Canadian Journal of Earth Sciences* 15:405–423, 6 figs.

Waring, C.A. 1917. Stratigraphic and faunal relations of the Martinez to the Chico and Tejon of Southern California. *California Academy of Sciences, Proceedings, Series 4* 4:41–124, pls. 7–16.

Webster, M.L. 1983. New species of *Xenophora* and *Anchura* (Mollusca: Gastropoda) from the Cretaceous of Baja California Norte, Mexico. *Journal of Paleontology* 57:1090–1097, 3 figs.

Whiteaves, J.F. 1876. On some invertebrates from the coal-bearing rocks of the Queen Charlotte Islands. *Canada Geological Survey, Mesozoic Fossils* 1:1–92, pls. 1–10.

———. 1879. On the fossils of the Cretaceous rocks of Vancouver and adjacent islands in the Strait of Georgia. *Canada Geological Survey, Mesozoic Fossils* 1:93–190, pls. 11–20.

———. 1895. On some fossils from the Nanaimo Group of the Vancouver Cretaceous. *Royal Society of Canada, Transactions and Proceedings, Series 2* 1:119–133, pls. 2–3.

———. 1896. On some fossils from the Nanaimo Group of the Vancouver Cretaceous. *Royal Society of Canada, Transactions and Proceedings [for 1895], Series 2* 1:119–133, pls. 2–3.

———. 1903. On some additional fossils from the Vancouver Cretaceous, with a revised list of species therefrom. *Canada Geological Survey, Mesozoic Fossils* 1:309–415, pls. 40–51.

Woods, H. 1904–1913. *A monograph of the Cretaceous Lamellibranchia of England,* vol. 2. London: Palaeontographical Society, 473 pp., 62 pls., 252 text figs.

———. 1906. The Cretaceous fauna of Pondoland. *South African Museum, Annals* 4:275–350, pls. 33–44.

Yabe, H. 1904. Cretaceous Cephalopoda from Hokkaido. Part II. *Imperial University of Tokyo, College of Science, Journal* 20:1–45, pls. 1–6.

Yabe, H., and T. Nagao. 1925. New or little known Cretaceous fossils from north Saghalin. *Tohoku Imperial University, Science Report, Series 2, Geology* 7:111–124, pls. 28–29.

Received 15 July 1991; accepted 30 October 1991.

LOCALITIES CITED

Geographic areas (bracketed number) of the cited localities are plotted on Figure 1. Type localities of species described in this paper are fully described. Previously published localities are briefly characterized and referenced.

Appendix Text Table

[28]	6	SDSU: See LACMIP loc. 11629 (Sundberg, 1979, p. 173).
[26]	86	CIT: See LACMIP loc. 10120 (Saul, 1974, p. 1093; Saul, 1978, p. 55).
[30]	A-467	UCMP: Cayolitos Creek—name given to small unnamed creek not on map—6 miles [9.654 km] north of San Antonio del Mar, Baja California, Mexico. Coll.: Santillan and Barrera. Rosario Formation. Early Maastrichtian.
[8]	660	USGS: See USGS loc. 21369.
[29]	954	CAS: NE side of Punta Banda, southwest border of Todos Santos Bay, Baja California, Mexico. In beach cliff accessible at low tide, 3 miles [4.827 km] from La Grulla gun club house. Coll.: E. K. Jordan and L. G. Hertelin. Rosario Formation. Early Maastrichtian.
[26]	974	CIT: See LACMIP loc. 10105 (Matsumoto, 1960, p. 99).
[11]	1016	CIT: See LACMIP loc. 10847 (Matsumoto, 1960, p. 101).
[11]	1017	CIT: See LACMIP loc. 10849 (Popenoe and Saul, 1987, p. 34).
[11]	1041	CIT: See LACMIP loc. 10835 (Saul and Popenoe, 1962, p. 328; Popenoe et al., 1987, p. 98).
[9]	1051	USGS: Texas Springs, Shasta Co., California. Budden Canyon Formation. Late early Albian, *Brewericeras hulenense* Zone (Saul, 1978, p. 56).
[24]	1158	CIT: See LACMIP loc. 10710 (Popenoe and Saul, 1987, p. 34).
[24]	1159	CIT: See LACMIP loc. 10715 (Matsumoto, 1960, p. 103).
[26]	1164	CIT: See LACMIP loc. 10079.
[11]	1183	CIT (= UCLA loc. 3648): See LACMIP loc. 10861 (Matsumoto, 1960, pp. 15, 103, 157).
[8]	1232	CIT: See LACMIP loc. 10824 (Saul, 1978, p. 56).
[3]	1400	CIT: See LACMIP loc. 10446 (Matsumoto, 1960, p. 107).

Appendix Text Table. Continued.

[31]	1431	CAS: Cretaceous fossils near mouth of Arroyo Catarina, Baja California, Mexico. Coll.: C. H. Sternberg, 1928. Rosario Formation. Early Maastrichtian.
[26]	2167	UCMP: Williams Canyon, Santa Ana Mts., Orange Co., California. Ladd Formation, Holz Shale Member. Mid-Campanian (Packard, 1922, p. 416).
[26]	2169	UCMP: Santiago–Aliso divide, Santa Ana Mts., Orange Co., California. Williams Formation, Pleasants Sandstone. Late Campanian (Packard, 1922, p. 416).
[26]	2323	UCLA: Sandstone exposed on south end of low hill north of gully, about 2600′ [792.48 m] north of Holz Ranch house, Silverado Canyon, 2100′ [640.08 m] south, 390′ [118.872 m] west of northeast corner Sec. 7, T5S, R7W, Black Star Canyon Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, 1946. Ladd Formation, Baker Canyon Member. Turonian.
[15]	2359	CAS: Head of Deer Valley, Hooper Ranch, T1N, R2E, MDBM, Contra Costa Co., California. Great Valley Series, Deer Valley Formation of Colburn (1964). Late Maastrichtian.
[26]	2415	UCLA: Bee Canyon, El Toro Quadrangle, Orange Co., California. Williams Formation, ?Pleasants Sandstone. Late Campanian, *Metaplacenticeras pacificum* Zone (Matsumoto, 1960, p. 154; Saul, 1978, p. 56).
[15]	2609	UCMP: Probably loc. 1 of Merriam (1897, p. 768), hills southwest of Martinez, west side Alhambra Valley, Contra Costa Co., California. Coll.: J. C. Merriam. Great Valley Series. Late Maastrichtian.
[31]	2855	LACMIP: West side Arroyo Santa Catarina, Baja California, Mexico. Rosario Formation. Early Maastrichtian (Webster, 1983, pp. 1091, 1096).
[27]	3162A	SDSNH: Carlsbad Research Center, Carlsbad, San Diego Co., California. Point Loma Formation. Early Maastrichtian (Popenoe and Saul, 1987, p. 35).
[31]	3268	UCLA: Olive silts exposed along banks of "Ammonite Ravine," about 3 miles [4.8/8 km] northeast of Santa Catarina Landing and ¼ mile south of channel of Arroyo Santa Catarina, 5.9 km north, 5.9 km east of mouth of Arroyo Santa Catarina, Baja California, Mexico. Coll.: W. P. Popenoe et al., February 1949. Rosario Formation. Early Maastrichtian.
[15]	3313	UCLA: South side of Deer Valley, Contra Costa Co., California. Great Valley Series, Deer Valley Formation of Colburn (1964). Late Maastrichtian (Saul, 1974, p. 1097).
[11]	3623	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Musty Buck Member. Santonian (Matsumoto, 1960, p. 155).
[11]	3625	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Musty Buck Member. Santonian (Saul and Popenoe, 1962, p. 328).
[11]	3627	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Musty Buck Member. Santonian, *Baculites capensis* Zone (Matsumoto, 1960, p. 156).
[11]	3635	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian (Popenoe and Saul, 1987, p. 36).
[11]	3637	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian, *Baculites chicoensis* Zone (Matsumoto, 1960, pp. 15, 156).
[11]	3641	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian, *Baculites chicoensis* Zone (Saul, 1983, p. 121).
[11]	3642	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian, *Baculites chicoensis* Zone (Matsumoto, 1960, p. 156).
[11]	3643	UCLA: Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian, *Bac-*

Appendix Text Table. Continued.

Appendix Text Table. Continued.

		ulites chicoensis Zone (Saul, 1974, p. 1093).
[11]	3648	UCLA: "Fossil Bluff," Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian, *Baculites chicoensis* Zone (Saul, 1988, p. 24).
[30]	3796	UCLA: Boulder at base of seacliff 5600′ [1706.88 m] north of mouth of Arroyo San Antonio del Mar, Johnson's Ranch, about 35 miles [56.21 km] south of Santo Tomás, Baja California, Mexico. Coll.: W. P. Popenoe, 1949. Rosario Formation, Early Maastrichtian.
[9]	3916	UCLA: Texas Springs area, 1000′ [304.8 m] north, 1600′ [487.68 m] west of southeast corner Sec. 29, T31N, R5W, Redding Quadrangle, Shasta Co., California. Coll.: P. U. Rodda. Budden Canyon Formation. Late early Albian, *Brewericeras huelenense* Zone.
[15]	3957	UCLA: South slope of shallow saddle on crest of north-trending spur 2200′ [670.56 m] south, 15° west of northeast corner Sec. 24, T1N, R1E, south side of Deer Valley, Antioch South Quadrangle, Contra Costa Co., California. Coll.: W. P. Popenoe, 1944. Great Valley Series, Deer Valley Formation of Colburn (1964). Late Maastrichtian.
[14]	3976	UCLA: Blocks of coarse sandstone in wheatfield north of P.G. & E. Station, southwest side of 200′ [60.96 m] hill, about 2500′ [762 m] south 70° east of the northwest corner Sec. 33, T3N, R3W, east side of Glenn Cove and west of Southampton Bay, north side Carquinez Strait, Carquinez Quadrangle, Solano Co., California. Coll.: W. P. Popenoe, August 28, 1944. Great Valley series. Late Campanian.
[22]	M4017	USGS: California, Southern Coast Range, Santa Barbara Co., San Rafael Primitive Area. Hurricane Deck 1964 Quadrangle, approx. 12,850′ [3916.68 m] north, 13,200′ [4023.36 m] west of southeast corner. Alt. approx. 2240′ [682.752 m]. On southwest side of Sisquoc River near mouth of Foresters Leap Canyon. About 2¼ miles [3.6135 km] northwest of South Fork Guard Station and 8 miles [12.848 km] eastnortheast from Nira Camp at end of Sunset Valley Road. Coll.: J. G. Vedder, 1965. ?Early Maastrichtian.
[8]	4106	UCLA: North of Clover Creek, Shasta Co., California. Redding Formation, Member VI. Early Santonian (Popenoe, 1983, pp. 760, 765).
[22]	4116	UCLA: Fine grained, gray arkosic sandstone, in bed of Jalama Creek, 1230′ [374.904 m] southwest of corral, 0.79 miles [1.26874 km] south and 2.85 miles [4.5771 km] east of Jalama Ranch Headquarters, 0.31 miles [0.49784 km] north, 1.88 miles [3.01928 km] west of southeast corner of topo sheet, Lompoc Hills Quadrangle, 1947, Santa Barbara Co., California. Coll.: D. H. Dailey, August, 1958. Jalama Formation. Early Maastrichtian.
[22]	4118	UCLA: Medium grained, dark bluish-gray, arkosic sandstone, in bed of Jalama Creek, elev. 350′ [106.68 m], 0.56 miles [0.89936 km] south, 1.85 miles [2.9711 km] east of Jalama Ranch Headquarters, 0.54 miles [0.86724 km] north, 2.81 miles [4.51286 km] west of southeast corner of topo sheet, Lompoc Hills Quadrangle, 1947, Santa Barbara Co., California. Coll.: D. H. Dailey, July, 1958. Jalama Formation, Member V. Early Maastrichtian.
[22]	4120	UCLA: Fine to medium grained, buff, arkosic sandstone, 200′ [60.96 m] north of Jalama Creek, elev. 374′ [113.9952 m], 0.43 miles [0.69058 km] south, 1.75 miles [2.8105 km] east of Jalama Ranch Headquarters, 0.67 miles [1.07602 km] north, 2.9 miles [4.6574 km] west of southeast corner of topo sheet, Lompoc Hills Quadrangle, 1947, Santa Barbara Co., California. Coll.: D. H. Dailey, August, 1958. Jalama Formation, Member V. Early Maastrichtian.
[22]	4131	UCLA: In hard, gray, sandy conglomerate along top of first ridge about 1044′ [318.2112 m] northwest of corral, elev. 750′ [228.6 m], 0.54 miles [0.86724 km] south, 2.93 miles [4.70558 m]

Appendix Text Table. Continued.

		east of Jalama Ranch Headquarters, 0.56 miles [0.89936 km] north, 1.73 miles [2.77838 km] west of southeast corner of topo sheet, Lompoc Hills Quadrangle, 1947, Santa Barbara Co., California. Coll.: D. H. Dailey, July, 1958. Jalama Formation, Member V. Early Maastrichtian.
[22]	4143	UCLA: Top of ridge, 900′ [274.32 m] north of Jalama Creek, elev. 625′ [190.5 m], 0.52 miles [0.83512 km] south, 1.98 miles [3.17988 km] east of Jalama Ranch Headquarters, 0.58 miles [0.93148 km] north, 2.69 miles [4.32014 km] west of southeast corner of topo sheet, Lompoc Hills Quadrangle, 1947, Santa Barbara Co., California. Coll.: W. P. Popenoe, 1938; D. H. Dailey, August, 1958. Jalama Formation, Member III. Early Maastrichtian.
[8]	4209	UCLA: Clover Creek, Millville Quadrangle, Shasta Co., California. Redding Formation, Member IV. Coniacian (Popenoe and Saul, 1987, p. 36).
[8]	4217	UCLA: Clover Creek, Shasta Co., California. Redding Formation, Member VI. Late Santonian (Popenoe, Saul, and Susuki, 1987, p. 100—erroneously as "4127").
[8]	4219	UCLA: Southeast side of Oak Run valley, 1000′ [304.8 m] south, 1900′ [579.12 m] east of northwest corner Sec. 15, T32N, R2W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, August 30, 1959. Redding Formation, sandstone interbedded with conglomerate of Member V. Santonian.
[8]	4245	UCLA: South side of Clover Creek valley at center of west line Sec. 33, T32N, R2W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe and D. H. Dailey, August 25, 1959. Redding Formation, ?Member IV, sandstone bed 30′ [9.144 m] to 40′ [12.192 m] strat. above conglomerate bed. Late Coniacian.
[7]	4250	UCLA: Young Ranch, Yreka Quadrangle, Siskiyou Co., California. Hornbrook Formation. Late Turonian (Saul and Popenoe, 1962, p. 329).
[7]	4251	UCLA: Sandstone cropping out

Appendix Text Table. Continued.

		along ridge by ranch road on Young Ranch, about 2300′ [701.04 m] slightly west of due north of the ranch house, approx. 350′ [106.68 m] west of UCLA 4250, 850′ [259.08 m] south, 3000′ [914.4 m] west of northeast corner Sec. 26, T46N, R6W, Yreka Quadrangle, 9 miles [14.454 km] northeast of Yreka, Siskiyou Co., California. Coll.: M. A. Murphy, W. P. Popenoe, and Takeo Susuki, August 30, 1951. Hornbrook Formation. Turonian.
[13]	4285	UCLA: South slope of hill at about 1000′ [304.8 m] contour, on east side of Antelope Creek valley, from calcareous slump blocks in shale. NW ¼, SW ¼ Sec. 5, T16N, R4W, about 2.8 miles [4.4968 km] due south of Sites, Lodoga 1943, 15′ Quadrangle, Colusa Co., California. Coll.: Todd Harding. Great Valley Series. ?Albian.
[16]	4348	UCLA: Float boulder, shoreline, rocky covelet, south side of elongate seaward pointing rock just south of Bolsa Point, Pigeon Point Quadrangle, San Mateo Co., California. Coll.: L. R. and R. B. Saul, October 11, 1960. Pigeon Point Formation. Mid-Campanian.
[10]	4370	UCLA: See LACMIP loc. 10871.
[5]	4669	UCLA: Sandstone cropping out in field about ¼ mile [0.4015 km] north of road from Suplee to Paulina, and in center of SW ¼ Sec. 23, T17S, R25E, Dayville Quadrangle, Crook Co., Oregon. Coll.: R. W. Imlay and W. P. Popenoe, June 20, 1959. Bernard Formation. Cenomanian.
[30]	4863	UCLA: North side of Arroyo San Antonio del Mar, about 1 mile from coast and north 12° west from "Johnson's Ranch" house, Baja California, Mexico. Coll.: W. P. Popenoe, H. Lusk, and C. Helms, February 3, 1949. Rosario Formation. ?Late Campanian or early Maastrichtian.
[7]	5422	UCLA: Rancheria Gulch, about 1 mile [1.606 km] west of Henley and approx. 400′ [121.92 m] north, 2000′ [609.8 m] west of southeast corner Sec. 19, T47N, R6W, Yreka Quadrangle, Siski-

Appendix Text Table. Continued.

		you Co., California. Coll.: W. P. Popenoe, summer 1951. Hornbrook Formation. Osburger Gulch Member. Turonian.
[20]	5522	UCLA: Ridge southeast from Garza Peak, approx. 1 mile [1.606 km] west of Sagaser Ranch house, 2350′ [716.28 m] north, 2300′ [701.04 m] west of southeast corner Sec. 13, T23S, R16E, Garza Peak Quadrangle, Reef Ridge area, Kings Co., California. Coll.: E. V. Tamesis, 1965. Panoche Formation, clast in conglomerate. Turonian.
[31]	5989	LACMIP: South side, north fork of Ammonite Ravine, about 275′ [83.82 m] east of LACMIP 5988. Float fossils collected at elev. 205′ [62.484 m], Arroyo Santa Catarina, Baja California, Mexico. Coll.: M. L. Webster, December 23, 1966. Rosario Formation. Early Maastrichtian.
[24]	6020	UCLA: North bank of Bell Canyon, just east of mouth of large gully and 500′ [152.4 m] south, 9000′ [2743.2 m] west of northeast corner Sec. 4, T1N, R17W, Calabasas Quadrangle, Simi Hills, Ventura Co., California. Coll.: L. R. Saul and F. H. Weber, Jr., June 24, 1971. Chatsworth Formation. Mid-Campanian.
[5]	6165	LACMIP: Andy Bernard Ranch, 2.5 miles north of Suplee, west side of ravine that drains southward into tributary creek to the south fork of Beaver Creek, northeast of the ranch house, SW ¼, SE ¼ Sec. 1, T17S, R25E, Dayville Quadrangle, Crook Co., Oregon. Coll.: Janet Dock, August 27, 1981. Bernard Formation. Cenomanian.
[24]	6232	UCLA: Bell Canyon, very fossiliferous sandstone bed in northwest slope of creek on east slope of north–south spur, 500′ [152.4 m] south, 5800′ [1767.84 m] west of northwest corner Sec. 4 and Ventura Co. line, Calabasas Quadrangle, Simi Hills, Ventura Co., California. Coll.: R. B. Saul, June 24, 1971. Chatsworth Formation. Mid-Campanian.
[18]	6345	UCLA: West side San Joaquin Valley, approx. 2 miles [3.218 km] south of Ortigalita Creek, 3200′ [975.36 m] north, 4650′ [1417.32 m] east of southwest corner Sec. 33, T11S, R10E, Ortigalita Peak Quadrangle, Merced Co., California. Coll.: R. B. Stewart and W. P. Popenoe, 1944. Moreno Formation, Tierra Loma Member. Late early Maastrichtian.
[19]	6370	UCLA: Northeast side of Cooper Canyon, approx. 1350′ [411.48 m] north, 2200′ [670.56 m] west of southeast corner Sec. 2, T21S, R14E, Coalinga Quadrangle, Alcalde Hills, Fresno Co., California. Coll.: John Alderson, June 18, 1977. Panoche Formation, "Alcalde Shale," reworked clast in conglomerate. Turonian.
[21]	6526	UCLA: South side Lake Nacimiento, poorly sorted conglomeratic sandstone east side of narrows of Dip Creek, elev. approx. 740′ [225.552 m], 1500′ [457.2 m] south, 400′ [121.92 m] west of northeast corner Sec. 30, T25S, R10E, Lime Mountain Quadrangle, San Luis Obispo Co., California. Dip Creek Formation of Taliaferro, 1944. Late late Maastrichtian.
[33]	6973	UCLA: Approx. 3.3 km south, 13° west of Campitos, northwest end of Vizcaíno Peninsula, about 21 km east of Punta Eugenia, Baja California Sur, Mexico. Coll.: David Bernal, 1979–1980. Basal upper Valle Formation. ?Cenomanian.
	M6981	USGS: Alaska, Alaska Peninsula, Chignik B-2 Quadrangle. Lat. 56°25′59″N, long. 158°34′20″W Sec. 5. Same locality as M6979 about 2.6 miles [4.1834 km] northeast of house. Massive greenish sandstone several hundred feet higher in section than 41B. Coll.: R. L. Detterman, 1977. Chignik Formation. Early Campanian, *Inoceramus schmidti* Zone.
[17]	7174	UCLA: Orestimba Creek, T7S, R7E, Orestimba Quadrangle, Diablo Range, Stanislaus Co., California. Moreno Formation, Quinto Silt. Late Maastrichtian.
[18]	M8573	USGS: NE ¼, SE ¼, NW ¼ Sec. 20, T23S, R17E, Garza Peak Quadrangle, Kings Co., California. 35°55.38′N, 120°9.38′W. Conglomeratic boulders in float at bottom of gully in conglomer-

Appendix Text Table. Continued.

		ate. Coll.: W. P. Elder, 1989. Panoche Formation. Cenomanian.
[16]	M8601	USGS: In lens in sandstone on beach 0.3 miles [0.4827 km] southeast of Bolsa Point, lat. 37°11.61′N, long. 122°23.94′W, Pigeon Point Quadrangle, San Mateo Co., California. Coll.: W. P. Elder, 1989. Pigeon Point Formation. Campanian
[18]	M8649	USGS: Clasts? (individual clasts lettered) in conglomerate on north nose of hill 443, elev. 390′ [118.872 m], SW ¼, NE ¼, NW ¼ Sec. 24, T10S, R8E, San Luis Dam Quadrangle, Merced Co., California. Coll.: W. P. Elder and A. Benison, 1990. Panoche Formation. Coniacian.
[26]	10079	LACMIP (= CIT loc. 1164): South side Silverado Canyon near mouth of small north-flowing gully, and at top of lower fossiliferous sandstone series, about 400′ [121.92 m] southeast of Holz Ranch house, 1025′ [312.42 m] north, 150′ [45.72 m] east of southwest corner Sec. 8, T5S, R7W, El Toro Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, May 15, 1935. Ladd Formation, Baker Canyon Member. Turonian.
[26]	10096	LACMIP (= CIT loc. 1052): Crest of small spur near head of Alisos Creek drainage about 3750′ [1143 m] east of Pankratz Ranch house, 600′ [182.88 m] south, 175′ [53.34 m] north of northwest corner Sec. 32 and east edge of topo sheet, T5S, R7W, El Toro Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, January, 1933. Williams Formation, Pleasants Sandstone. Late Campanian, *Metaplacenticeras pacificum* Zone.
[26]	10105	LACMIP (= CIT loc. 974): Santiago–Aliso Creek divide, Santa Ana Mts., Orange Co., California. Williams Formation, Pleasants Sandstone. Late Campanian (Matsumoto, 1960, p. 99).
[26]	10120	LACMIP (= CIT loc. 86): Santa Ana Mts., Orange Co., California. Williams Formation, Pleasants Sandstone Member. Late Campanian.
[26]	10135	LACMIP (= CIT loc. 1290): South side of prominent hill west of spring, about 1500′ [457.2 m] north of Holz ranch house, Silverado Canyon, 2600′ [792.48 m] south, 200′ [60.96 m] west of northeast corner Sec. 7, T5S, R7W, Black Star Canyon Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: Popenoe, Henshal, Wells, Church, and Fiedler, April 6, 1937. Ladd Formation, Baker Canyon Member, near top. Turonian.
[3]	10446	LACMIP (= CIT loc. 1400): Sucia Island, San Juan Co., Washington. Cedar District Formation. Mid-Campanian, *Hoplitoplacenticeras vancouverense* Zone (Matsumoto, 1960, p. 107).
[22]	10690	LACMIP (= CIT loc. 590): Jalama Ranch Creek, Lompoc Hills Quadrangle, western Santa Ynez Range, Santa Barbara Co., California. Jalama Formation. Early Maastrichtian (Saul, 1978, p. 55).
[22]	10695	LACMIP (= CIT loc. 602): Float, Jalama Creek, 3.2 miles [5.1488 km] eastsoutheast of Jalama Ranch house, Lompoc Hills Quadrangle, Santa Ynez Mts., Santa Barbara Co., California. Coll.: W. S. W. Kew. Jalama Formation. Early Maastrichtian.
[24]	10709	LACMIP (= CIT loc. 1157): North bank Bell Canyon in shale bluffs above stream channel, about 50′ [15.24 m] below base of heavy Cretaceous sandstone, 1 mile [1.609 km] due west of Los Angeles–Ventura Co. line, on boundry (extended) between T1 and 2N, R27W, Calabasas Quadrangle, southeast slope Simi Hills, Ventura Co., California. Coll.: W. P. Popenoe, June 18, 1935. Chatsworth Formation. Mid-Campanian.
[24]	10710	LACMIP (= CIT loc. 1158): Bell Canyon, Simi Hills, Ventura Co., California. Chatsworth Formation. Mid-Campanian (Popenoe and Saul, 1987, p. 34).
[24]	10715	LACMIP (= CIT loc. 1159): Dayton Canyon, Simi Hills, Calabasas Quadrangle, Los Angeles Co., California. Chatsworth Formation. Late Campanian, *Metaplacenticeras pacificum* Zone (Matsumoto, 1960, p. 103).
[26]	10719	LACMIP (= CIT loc. 1066): Crest

Appendix Text Table. Continued.

		of ridge between Baker and Black Star Canyons, about 6600′ [2011.68 m] upstream from mouth of Black Star Canyon along firebreak on Black Star Canyon side of ridge, 2300′ [701.04 m] north, 175′ [53.34 m] east of southwest corner Sec. 31, T4S, R7W, Black Star Canyon Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, June 26, 1934. Williams Formation, basal Schultz Conglomerate Member. Late early Campanian.
[8]	10769	LACMIP (= CIT loc. 1203): Lens in sandstone cropping out in bed of Dry Creek, 700′ [213.36 m] south, 300′ [91.44 m] west of northeast corner Sec. 6, T32N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe and Ahlroth, June 23, 1936. Redding Formation, Bellavista Sandstone. Turonian.
[8]	10782	LACMIP (= CIT loc. 1191): Sandstones about 150 yards [137.16 m] east of Stinking Creek, near base of Cretaceous section, 3530′ [1075.944 m] north 37°30′ west of southeast corner Sec. 6, T32N, R3W, Redding Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe and Ahlroth, June 20, 1936. Redding Formation, Bellavista Sandstone. Turonian.
[8]	10824	LACMIP (= CIT loc. 1232): Price Hollow, Oak Run, Shasta Co., California. Redding Formation, Member V. Early Santonian (Saul, 1978, p. 56).
[11]	10834	LACMIP (= CIT loc. 1040): Limy sandstone beds cropping out along west bank Butte Creek, just under Tertiary gravels, 3.8 miles [6.1142 km] upstream from Honey Run Road covered bridge over Butte Creek, and 10.2 miles [16.4118 km] along Humbug Road from U.S. Hwy 99E, 450′ [137.16 m] north, 600′ [182.88 m] east of southwest corner Sec. 8, T22N, R3E, Paradise Quadrangle, Butte Co., California. Coll.: W. P. Popenoe and W. A. Findlay, September 3, 1933. Chico Formation, Ten Mile Member. Early Campanian, *Baculites chicoensis* Zone.
[11]	10847	LACMIP (= CIT loc. 1016): Chico Creek, Butte Co., California. Chico Formation, Musty Buck Member. Santonian (Matsumoto, 1960, p. 101).
[11]	10849	LACMIP (= CIT loc. 1017): Chico Creek, Butte Co., California. Chico Formation, Musty Buck Member. Santonian (Popenoe and Saul, 1987, p. 34).
[11]	10861	LACMIP (= CIT loc. 1183): "Fossil Bluff," Chico Creek, Paradise Quadrangle, Butte Co., California. Chico Formation, Ten Mile Member. Early Campanian (Matsumoto, 1960, pp. 15, 103, 157).
[10]	10871	LACMIP (= CIT loc. 1020; UCLA loc. 4370): Sandstone boulder in heavy conglomerate, channel of Elder Creek, planetable traverse station S-18, Tehama Co., California. Coll.: W. P. Popenoe and W. A. Findlay, August 18, 1933. Great Valley Series, Budden Canyon Formation. Cenomanian or ?late Albian.
[6]	10903	LACMIP (= CIT loc. 1622): Soft gray sandstone cropping out along irrigation ditch 150′ [45.72 m] to 200′ [60.96 m] above and to southwest of Southern Pacific RR track and about 4 miles [6.436 km] southeast of U.S. hwy bridge over Ashland Creek, Ashland, near midpoint of west boundary Sec. 24, T39S, R1E, Ashland Quadrangle, Jackson Co., Oregon. Coll.: W. P. Popenoe and W. A. Findlay, July 12, 1933. Hornbrook Formation. Turonian.
[28]	11629	LACMIP (= SDSU loc. 6): Top of basal sandstone just below base of mudstone sequence, stratigraphically above LACMIP loc. 11628, west of La Jolla Cove, La Jolla Quadrangle, La Jolla Bay, San Diego Co., California. Coll.: SDSU field classes. Rosario Group, Point Loma Formation. ?latest Campanian–earliest Maastrichtian.
[34]	11944	LACMIP: Approx. 10 km north of Punta Abreojos (southwest of San Ignacio), in first ridges north of arroyo that crosses Punta Abreojos road (dirt) just south of Campo Rene turnoff, approx. 2 km northwest of road and 2–3 km up ravine, Vizcaíno Peninsu-

Appendix Text Table. Continued.

		la, Baja California Sur, Mexico. Coll.: Robert Demetrion, 1987. Valle Formation. Mid-Campanian, *Hoplitoplacenticeras ?* Zone.
[21]	12245	LACMIP: Midway between Pebblestone Shut-In and Grizzly Bend at an elev. of about 750′ [228.6 m], 35°44′28″N, 121°03′01″W, Sec. 19, T25S, R9E, Pebblestone Shut-In Quadrangle, San Luis Obispo Co., California. Coll.: V. M. Seiders, 1985. ?El Piojo Formation, single clast in conglomerate. ?Early Maastrichtian.
[8]	21369	USGS (= USGS loc. 660): "1 mi. [1.609 m] SE of Buckeye," vicinity of Dry Creek, Shasta Co., California. Coll.: J. S. Diller, 1887. Redding Formation. Turonian.
[15]	25707	CAS: East end of Deer Valley, near forks of Brentwood road, SW ¼ Sec. 27, T1N, R2E, Antioch South Quadrangle, Contra Costa Co., California. Coll.: F. M. Anderson and B. L. Clark. Great Valley Series, Deer Valley Formation of Colburn (1964). Maastrichtian.
[11]	27835	CAS: Bluff on southeast side of Chico Creek, 1.3 miles [2.0917 km] by road southwest of bridge across Big Chico Creek at Frank Mickey's place, Sec. 13, T23N, R2E, Paradise Quadrangle, Butte Co., California. Coll.: Taff, Hanna, and Cross, May 3, 1934 and February 16, 1935. Chico Formation, Musty Buck Member. Santonian.
[11]	27836	CAS: Chico Creek, Sec. 1, T23N, R2E, Paradise Quadrangle, Butte Co., California. Coll.: Taff, Hanna, and Cross. Chico Formation, Ponderosa Way Member. ?Coniacian.
[11]	27838	CAS: Southeast bank of Big Chico Creek, 3.6 miles [5.7924 km] by road from 10 Mile House on Humboldt Road, 3.1 miles [4.9879 km] by road south of bridge at Mickey's place, SE ¼ Sec. 23, T23N, R3E, Paradise Quadrangle, Butte Co., California. Coll.: Taff, Hanna, and Cross. Chico Formation, Ten Mile Member. Early Campanian, *Submortoniceras chicoense* Zone.
[17]	27854	CAS: Orestimba Creek, Mt. Boardman Quadrangle, Stanislaus Co., California. Base of Panoche Formation, boulders in conglomerate. Coniacian (Matsumoto, 1960, p. 158).
[15]	28104	CAS: Curry Canyon, Contra Costa Co., California. Great Valley Series. Mid to late Cenomanian (Matsumoto, 1960, p. 84).
[18]	28118	CAS: North bank of Las Baños Creek, Merced Co., California. Quinto Silt. Maastrichtian.
[12]	28766	LACMIP: ¾ mile [1.20675 km] northwest of Stony Creek, SW ¼ Sec. 28, T22N, R5W, Fruto Quadrangle, Glenn Co., California. Coll.: P. W. Reinhart. Great Valley Series. Cenomanian.
[20]	28788	LACMIP: East of Big Tar Canyon Rd., north of Sunflower Valley [McLure Valley, of 1937 Reef Ridge Quadrangle], elev. 1420′ [432.816 m], 1500′ [457.2 m] south, 2700′ [822.96 m] west of northeast corner Sec. 20, T23S, R17E, Reef Ridge Quadrangle, Kings Co., California. Coll.: R. B. Stewart. Panoche Formation, boulder in conglomerate. Cenomanian.
[21]	29217	LACMIP: In creek, on line between Sec. 4 and 5, about 400′ [121.92 m] north of southwest corner Sec. 4, T25S, R9E, Bryson Quadrangle, creek is tributary to Cantinas Creek, northwest of Lake Nacimiento, San Luis Obispo Co., California. Coll.: V. M. Seiders, 1985. El Piojo Formation. Late Maastrichtian.
[9]	29230	LACMIP: Texas Springs area, sandstone cropping out in gully west of first ridge west of road along north–south boundary between Sec. 28 and 29, T31N, R5W, 1000′ [304.8 m] north, 750′ [228.6 m] west of southeast corner of the Redding Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, August 29, 1960. Budden Canyon Formation. Late early Albian, *Brewericeras hulenense* Zone.
[9]	29231	LACMIP: Loose slab on surface of sandstone slope, about ¼ mile [0.40225 km] west of road and ¼ mile [0.40225 km] south of LACMIP loc. 29230, approx. 1 mile [1.609 km] southwest of Texas Springs, SE ¼ Sec. 29, T31N,

Appendix Text Table. Continued.

		R5W, Redding Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, August 29, 1960. Budden Canyon Formation. Late early Albian, *Brewericeras hulenense* Zone.
[17]	29491	CAS: Upper part of Salado Creek, W ½ Sec. 34, T6S, R6E, Mt. Boardman Quadrangle, Stanislaus Co., California. Panoche Formation. Turonian.
[13]	31920	CAS: Thompson Creek, 1200′ [365.76 m] north, 600′ [182.88 m] west of southeast corner Sec. 20, T8N, R2W, Monticello Dam Quadrangle, Yolo Co., California. Coll.: W. E. Kennett, July 26, 1943. Great Valley Series, near base of Yolo Shale. Turonian.
[15]	33706	CAS: Arroyo del Valle, calcareous conglomerate, 1 mile [1.609 m] south of Aqueduct, Tesla Quadrangle, Alameda Co., California. Coll.: A. S. Huey. Panoche Formation. Early Turonian (Matsumoto, 1960, p. 95).
[26]	66028	CAS: Santa Ana Mts., Orange Co., California. Williams Formation, Pleasants Sandstone. Late Campanian.
[15]	66237	CAS (= SU loc. 1825): Alameda Co., ½ mile [0.8045 km] northeast of Niles, in conglomerate along road up south side of Niles Canyon, Niles 7.5 Quadrangle. Coll.: R. Anderson, June 1906. ?Oakland Conglomerate. Turonian.
[31]	66296	CAS (= SU loc. 91): 6 miles [9.654 km] north of Rosario Canyon, Baja California, Mexico. Coll.: B. Hake. "In conglom. in or on Cretac" ?Rosario Formation. ?Late Campanian.
[28]	66512	CAS: Point Loma, San Diego Co., California. Rosario Group. Early Maastrichtian.
[1]	83909	GSC: Southern shore of Denman Island. Collected from interval 150′ [45.72 m] to 250′ [76.2 m] southeast of the lighthouse, halfway between high and low water mark, from a thin conglomerate bed. British Columbia. Coll.: J. A. Jeletzky, July 21, 1969. Upper Trent River Formation.